SCIENTIFIC AMERICAN SUPPLEMENT. No. 1484

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Scientific American, established 1845.
Scientific American Supplement, Vol. LVII., No. 1484.

NEW YORK, JUNE 11, 1904.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

IRRIGATING FLUME LEADING FROM A TRIBUTARY OF THE SNAKE RIVER.

GOVERNMENT IRRIGATION WORK.

GOVERNMENT IRRIGATION WORK.*

By GUY E. MITCHELL.

MINIDOKA PROJECT.

Two million, six hundred thousand dollars has been appropriated out of the government reclamation fund for the irrigation of Idaho deserts by the waters of the Snake River.

THE SNAKE RIVER WATERSHED.

Secretary Hitchcock has finally approved the plans of the government engineers, and has set aside this sum out of the reclamation fund, for the work of constructing an immense irrigation system. Water is to be taken from the Snake River at the head of the Minidoka rapids, about six miles south of Minidoka, a station on the Oregon Short Line Railroad, and spread over the great Snake plains.

At the point of diversion the formation in the bed of the river is solid lava rock, and the conditions are very favorable for the construction of a dam 50 feet high and the diversion of water on both sides of the river into canals for the irrigation of lands under them. Above the dam site for many miles the stream is in a canyon or a very narrow valley from 40 to 150 feet below the bench lands, and the dam when constructed will back the water up for a distance of about 35 miles. Surveys show that it is possible to irrigate by gravity about 68,000 acres of good land; in addition to this it is possible to divert about 3,000 cubic feet of water per second, which is appropriated by vested interests below, and by turning this back into the river generate over 10,000 horse-power, which can be used to pump an ample supply of water to about 53,000 acres of land lying above the gravity canals, making a total area irrigable from this project of about 120,000 acres.

The engineers estimate that the cost of irrigation will be about $25 per acre. Similar lands when reclaimed are selling at from $40 to $100 per acre. The project has already been considered in its broad features by the leading citizens of Idaho, and in a recent letter the governor of the State transmitted a statement, signed by a great number of prominent people, heartily indorsing and recommending the approval of the Minidoka project, as tending in the largest measure to promote the development of the upper Snake River valley.

Works Proposed.

It is proposed to construct a rock-filled dam across the Snake River at the point of diversion. The material for this dam will be excavated from the upper end of the main north side canal. It will consist of an embankment of loose rock 575 feet in length, with masonry to wall. The rock embankment will be 12½ feet wide at the top, and will be carried 6 feet above extreme flood level. There will be a spillway on the south side of the river about 2,000 feet long. This spillway will be over a flat ridge of rock, which will be leveled up in place by a low masonry wall.

The north side canal for about 4,500 feet at its upper end will be in rock. It will be 67 feet wide, and carry water to a depth of 10 feet. At the lower end on this section will be located the power station, where 3,000 second-feet of this water will be discharged through wheels under a head of 50 feet. The power developed will be transmitted about 12 miles to the pumping station on the south side of the canal, where it will be applied in lifting water to lands lying above the gravity level. The present minimum supply for this purpose is 2,000 second-feet, enough to develop about 11,400 horse-power. This amount can be increased by storage to 3,000 second-feet, or enough for more than 17,000 horse-power.

In addition to these power possibilities, more than 2,000 horse-power can be developed from the 1,000 second-feet of irrigation water, which will fall 20 feet at this point. This amount of power will be available for purposes other than irrigation. The power station is designed to utilize this falling water both during the irrigation season and at other times.

From the power house the canal will have a capacity of 1,000 second-feet, and will irrigate by gravity nearly 60,000 acres of land. It will be located on practically level ground, and, after the first six miles, will be entirely in earth.

The south side canal will have a capacity of 800 second-feet for the first 12 miles, or to the pumping station. It will only irrigate about 8,000 acres by gravity. At the first pumping station 540 second feet will be lifted to a height of 24 feet, and 158 second feet to a height of 25.5 feet. The last amount will be carried on down the valley, and will irrigate 12,400 acres of land. The first amount, 540 second-feet, will be carried easterly about 4,000 feet in a canal, where 522 second-feet will be lifted to a height of 28 feet, and 220 second-feet of this amount will be distributed from this level. The remainder will again be lifted to a height of 29.5 feet.

The estimated cost of power development is based upon the installation of power units consisting of one pair of 48-inch cylinder turbines direct connected to a 2,500-kilowatt engine type generator running at 200 revolutions per minute. It is estimated that three of these units will be capable of developing the power needed for the pumping plant.

For the utilization of the fall of 20 feet at the north side irrigation canal, it is proposed to install three units, each consisting of a pair of 30-inch twin turbines coupled on a horizontal shaft connected to a large generator.

THE SNAKE RIVER DESERT.

The estimated cost of the pumping plant is based on the installation of fifteen pumps having an average capacity of about 110 second-feet. Each of these pumps will be directly connected on a vertical shaft with a 500-horse-power motor, the pump being submerged and discharging directly into the canal above.

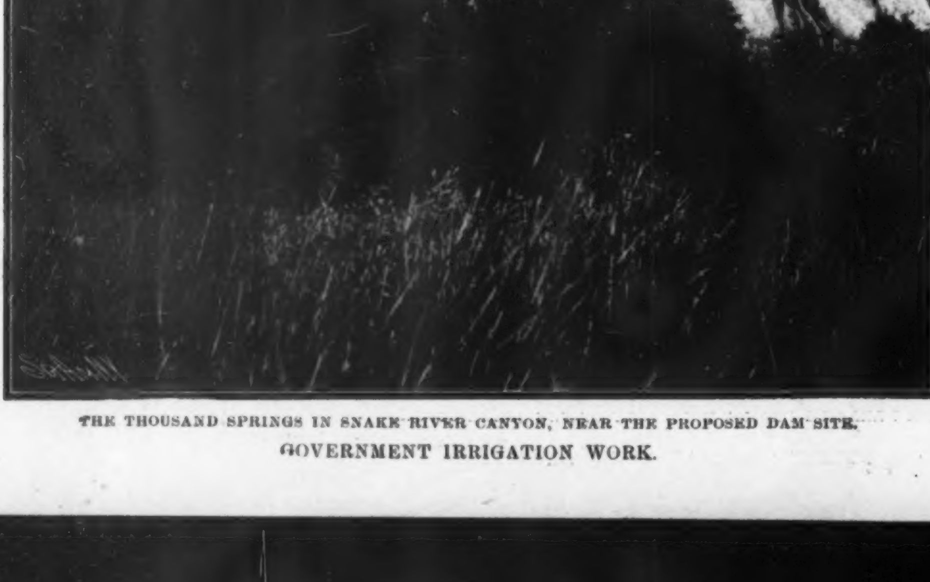
It is proposed to provide automatic regulating gates in the main canal just above the pumping station. Plans have been prepared for the dam and spillway, the temporary diverting channel with accompanying gates, and headgates to the power or forebay canal. In addition to the above, plans have been prepared of combined headgates and bridge for the north side irrigation canal, headgates for branch canal, automatic regulating gates for south side canal, two types of highway bridges, and preliminary plan of power and pumping station.

It is recommended by the engineers that the homestead entry under this project be limited to 80 acres, except within two miles of the town site, where the amount is limited to 40 acres, and it is believed that all these lands will be entered as soon as it is known that the works will be constructed. At the present time all but about 3,000 acres are vacant public lands. On the basis of an 80-acre homestead entry, this tract will provide homes for more than 1,400 families, or about 7,000 people.

The land under this project has long since been withdrawn from all speculative entry, and can only be taken through the original homestead law, requiring full residence and improvement. A promising feature of this project is that practically all the land is now government land; and when the government has provided the water, the homemaker himself will be able to deal directly with the government, rather than through the hands of middlemen.

By storage and the transfer of some of the surplus waters of May, June, and July to August and September, it will be seen from the accompanying diagram that during the entire summer irrigating season there would be an available supply of over 15,000 second-feet

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



THE THOUSAND SPRINGS IN SNAKE RIVER CANYON, NEAR THE PROPOSED DAM SITE.

GOVERNMENT IRRIGATION WORK.

—a flow of more than a million barrels every hour.

It is calculated by the engineers of the Reclamation Service that the waters of the Snake, fully utilized and the floods stored, will irrigate over 1,200,000 acres. This is allowing a liberal supply for the culture of such thirsty crops as alfalfa. With a later, more intensive farming and the growing of fruits and smaller crops, the water supply will go much further.

STRENGTH OF STEEL CASTINGS AT ORDINARY AND HIGH TEMPERATURES.

THE experiments by C. Bach, described in a paper recently published in the Zeitschrift des Ver. Deut. Ing., Nos. 49 and 50, are intended to ascertain the dependency of the mechanical strength of steel castings on temperature. They relate to castings from three different works, which are distinguished by the letters O, K, and M respectively. It is shown in the first place that the average tensile strengths will augment up to about 300 deg. C. The author does not note any appreciable influence of the duration of the load. For higher temperatures, on the other hand, the mean tensile strengths are found to decrease as follows for loads lasting about half an hour:

For casting O, from 4,788 (300 deg. C.) down to 2,691 kilogrammes per square centimeter (500 deg. C.), or from 68,099.72 pounds per square inch (572 deg. F.) down to 38,274.09 pounds per square inch (932 deg. F.)

For casting K, from 4,242 (300 deg. C.) down to 2,043 kilogrammes per square centimeter (500 deg. C.), or 60,333.96 pounds per square inch (572 deg. F.) to 29,057.58 pounds per square inch (932 deg. F.)

For casting M, from 4,319 (300 deg. C.) down to 2,274 kilogrammes per square centimeter (500 deg. C.), or from 61,429.13 pounds per square inch (572 deg. F.) down to 32,343.10 pounds per square inch (932 deg. F.)

For more prolonged loads (about 8 to 12 hours) there is a decrease in the tensile strength, which, at 500 deg. C., is as follows:

For casting K, from 2,043 down to 1,561 kilogrammes per square centimeter (22,201 pounds per square inch).

For casting M, 2,274 down to 1,911 kilogrammes per square centimeter (27,180 pounds per square inch).

As regards, on the other hand, the individual values for the tensile strength, there are, in the case of casting O the lowest departures at ordinary temperatures and the highest departures at 300 deg. C., whereas, in the case of K and M, 100 deg. and 20 deg. respectively (212 deg. and 68 deg. F.) will correspond with the minimum departures and 200 deg. (392 deg. F.) and 100 deg. with the highest departures.

The average fracture tensions are found to decrease, in the case of—

Casting O, from 25.5 per cent (20 deg. C.) down to 7.7 per cent (200 deg. C.)

Casting K, from 29.0 per cent (20 deg. C.) down to 17.7 per cent (200 deg. C.)

Casting M, from 27.2 per cent (20 deg. C.) down to 15.2 per cent (200 deg. C.)

For temperatures upward of 200 deg., the average fracture tension will augment again up to 33.3, 51.3, and 26.1 per cent respectively at the temperature of 500 deg. Prolonged loads will result in the tension being lowered at 300 and 400 deg., and augmented at the temperature of 500 deg. The individual values for the fracture tensions show departures among one another, which augment in some cases at extraordinary rates for increasing temperatures.

The average contractions of the cross section are found to decrease up to 300 deg., this decrease being—

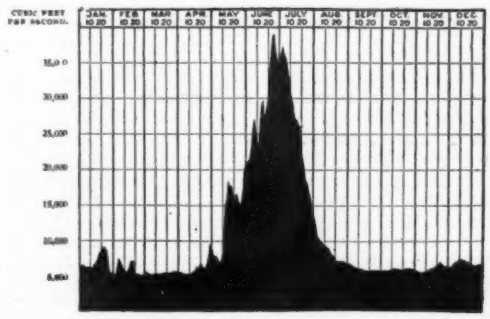
For casting O, from 50.4 (20 deg. C.) down to 15.8 per cent. (300 deg. C.)

For casting K, from 56.1 (20 deg. C.) down to 49.4 per cent. (300 deg. C.)

For casting M, from 48.7 (20 deg. C.) down to 34.7 per cent (300 deg. C.)

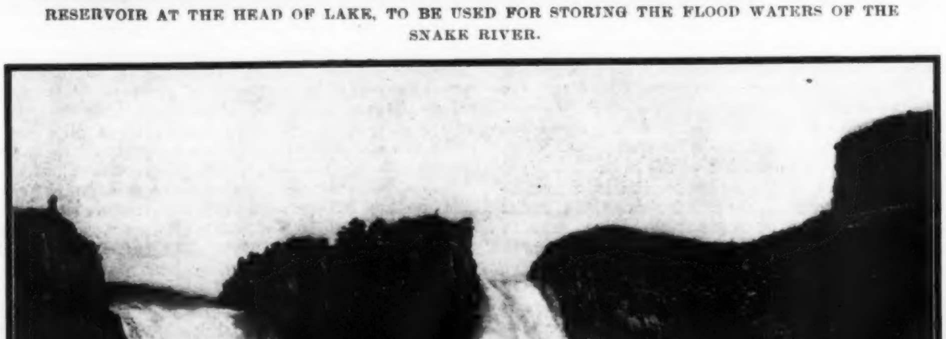
At higher temperatures there is once more an increase, values as high as 44.6, 75.7 and 42.1 respectively being noted at the temperature of 500 deg. There is, moreover, an influence of a prolongation of the load. The departures noted between the individual values are rather high.

From the above it is inferred that a steel casting, while appearing to be a very satisfactory and fairly uniform material with respect to its tenacity at ordinary temperatures, may present little tenacity and uniformity at high temperatures. This behavior should have an important bearing on the construction of steam boilers, etc., where the strength corresponding to ordinary temperatures is less important than that corresponding to higher temperatures.



AVAILABLE SUPPLY OF WATER DIAGRAMMATICALLY REPRESENTED.

RESERVOIR AT THE HEAD OF LAKE, TO BE USED FOR STORING THE FLOOD WATERS OF THE SNAKE RIVER.



TWIN FALLS OF THE SNAKE RIVER. HEIGHT OF FALL, 180 FEET.

GOVERNMENT IRRIGATION WORK.

THE USE OF THERMITE IN PRODUCING PURE METALS AND ALLOYS.

THE alumino-thermic process, consisting of the spontaneous combustion of a mixture of finely-divided aluminium and a metallic oxide, ignited in any one of its points, was originally devised by Dr. Goldschmidt for the production of pure metals and metallic alloys free from carbon. Yet this use of thermite required a special amount of experimental work in each case, in order to obtain metals of a uniform quality, and to operate with an efficiency satisfying commercial requirements. Other uses of the process, as, for instance, the welding of iron and steel pieces, were therefore developed first, and the alumino-thermic manufacture of metals and alloys (especially chromium and manganese) has entered a commercial stage only quite recently.

A sort of crucible is used, and several hundred pounds of metal are reduced in a single operation in scarcely thirty minutes time, on account of the rapidity of the reaction. Though the principle is to use equivalent amounts of the oxide and aluminium, it is advisable to use somewhat more of the oxide, on account of the great facility with which aluminium alloys itself. In fact, a suitable choice of the proportions of the mixture is the only means of controlling the reactions, so as to obtain metals free from aluminium.

The alumino-thermic method is, for instance, the only process allowing of producing fused chromium, free from carbon, with purity ranging between 98 per cent and 99 per cent; any impurities remaining are traces of iron and silicon. The metal is brittle, and remains bright for an indefinite length of time; its melting point is higher than that of platinum. The metal alloys with liquid steel, and, accordingly, allows of steels being produced with high percentages of chromium and with less carbon than in the case of ferro-chromium.

Whereas the carbonaceous manganese manufactured in the crucible crumbles when coming in contact with air, manganese of a purity of 99 per cent, free from carbon and technically free from iron, will resist atmospheric influences for an indefinite length of time. The metal is very brittle and easily crushed with a hammer, and it is remarkable for the easiness with which it may be fused with other metals. This manganese is used for obtaining alloys of any variety of combination, consisting mainly of zinc and copper. Such alloys may receive additions of manganese from a minimum up to unlimited percentages, resulting in a material increase of the strength, density, and frequently of the rolling capacity and malleability of the material.

Alloys consisting of tin and copper should not receive additions of manganese in the case of their containing upward of 2 to 3 per cent of tin, as in this case the manganese would produce the decomposition of the bronze, thus giving rise to an impairing instead of an improving of the material. On the other hand, any amount of manganese may be added with lower percentages of tin, when a corresponding improvement of quality will be observed, as in the case of zinc-copper alloys.

Manganese is further used in the case of nickel castings, with a view to obtaining a higher density; 2 per cent of manganese is the proper amount to be added to the fused metal. No noxious effects, as in the case of magnesium, will be produced with additions exceeding somewhat the proper limit. In mints, manganese is also added to the copper-nickel alloys (25 to 27) from which the nickel coins are made; the addition amounts to about 2 per cent of manganese.

For obtaining German silver and nickel alloys, manganese is also used to great advantage, the former receiving, even by an addition of a small amount of manganese, a brighter color, more similar to that of silver.

With aluminium alloys, an addition of manganese-copper, free from iron, is advantageous in the place of nickel or zinc, this addition (3 per cent) increasing the strength and producing a better working capacity of the alloy and a denser casting, apart from its being cheaper than an addition of nickel.

Copper and bronze castings lose their brittleness if manganese is added instead of phosphorus; the material thus obtained is easily threaded. Pure manganese-copper alloys are manufactured on a large scale, beginning with a percentage of 2 per cent of manganese, and increasing up to about 12 per cent. Bronzes containing 5 per cent to 6 per cent of manganese show about the same color as copper, and are remarkable, especially for their resistibility against the action of fire; they are accordingly used preferentially in connection with the fire-boxes of locomotives.

In the case of ferro-manganese, even of the best quality, being used, the copper will always absorb some iron, reducing considerably the malleability and resistivity to fire of the alloy. On the other hand, as pure manganese combines readily with copper, it is preferable to ferro-manganese, and its higher price is outbalanced by the uniformity and high quality of the casting.

High percentage manganese-copper alloys are manufactured by first melting the copper in a graphite crucible, when the manganese is added gradually in small pieces, and stirred violently. Before adding the manganese, the liquid copper slag should be taken off carefully. The temperature of the bath should be maintained at constant figures, and the metal stirred

several times after adding all the manganese. Such alloys are best cast in the form of thin rods, susceptible of being broken into smaller fragments. They are used also as fundamental alloys intended for further alloying.

Manganese alloys of tin or zinc, containing 20 parts of manganese and 80 parts of zinc, or 50 parts of manganese and 50 parts of tin, are also made readily, while an alloy of 30 per cent of chromium and 70 per cent of manganese is used for obtaining a copper compound called "chromium manganese." Chromium copper, containing 10 per cent of chromium, is also produced by the alumino-genetic process. Chromium manganese is combined with copper as readily as pure manganese; chromium, in opposition to iron, seems to augment the malleability of copper. As titanium is also alloyed with manganese, a manganese titanium has been brought out containing 30 per cent to 35 per cent of titanium, and serving as a base for further alloying with copper.

COMPOUND GOODS LOCOMOTIVE, SAXONY STATE RAILWAYS.

The locomotive illustrated is the outcome of a more than ordinary effort to improve the locomotive along lines which have already been admitted as practical in the wide field open for the improvement of this engine. Its most interesting feature is the "Klien" superheater, but here combined with compound cylinders, and the fitting of the trailing wheels with a peculiar radiating arrangement, so contrived that the driving wheels may easily accommodate themselves to short radius curves, while permitting the long side rods to remain parallel with the main frames. The practicability of pivoting the coupled axles has been proved by a three years' trial of the system as applied to eight-coupled engines for narrow gage mineral railways in Transylvania, where the minimum power in the form of hot water, ready to be converted into steam, even without counting the added heating surface of lengthened tubes, the relative efficiency of which at fire-box and smoke-box extremities will depend upon the size of the tubes, the conductivity of their metal, the nature of the coal, and the state of the fire, whether flame and smoke or incandescent without flame.

In the Saxon engine the superheater is placed in the smoke-box, where it takes up an appreciable quantity of the heat passing through on its way to the chimney. But the loss through the chimney must still remain important, and it was to employ this heat before its escape into the atmosphere that Jules Petiet, of the Chemin de Fer du Nord, forty-one years ago, passed the smoke-box gases backward through a tubular steam reservoir, very much resembling externally that of the Saxon locomotive, so that the steam and the products of combustion were discharged in the rear of the locomotive, just as in a return-flue boiler. The system was at that time simply termed "steam drying," or what we should now call moderate superheating from waste heat. Such locomotives as we mention were exhibited in the London Exhibition of 1862, and the last of them was used up in shunting work at Lille only a very few years since. A more generally correct designation for heat-saving apparatus in the smoke-box would undoubtedly be that of "economizers." With the ever-increasing size of locomotive engines, economizers are becoming more and more a promising means of increasing boiler efficiency.

In the locomotive under notice the serpentines are of 6 millimeters Mannesmann steel, and they raise the temperature in the low-pressure cylinder to 40 deg. Celsius—for the superheated steam does not enter the high-pressure cylinder at all, but only the low-pressure, the reheating taking place between the two cylinders.

From the main steam pipe and the elbow, steam having been abandoned some time ago because of its softness. The steam-ports in the valves are ½ inch wide, the maximum valve travel for the high-pressure is 4 11-16 inches, and for the low-pressure 4 13-16 inches. The lap is 1⅛ inches, the clearance to exhaust is ¼ inch for the high-pressure and nil, or line-and-line, for the low-pressure. The stuffing-boxes are fitted with the glands of the Metallic Packing Company, of Philadelphia. The pistons are steel castings, with cast-iron segments, and the piston-rods are of one piece with the guide extensions through the front covers. The front cover of the low-pressure cylinder is clipped in place by a wrought-iron ring bolted to the cylinder, and the back cover is cast solid. The valve gear is Walschaert's, but combined with a part of the Joy motion, for, as will be seen from the plan section to be given later, the great outstanding length of coupling pins, necessitated by the special combination of crank pins for inside frames and cranks for outside frames, prohibited the employment of the usual crank-rod drive for the Walschaert's valve gear, motion being obtained instead from the main connecting-rod in connection with the Joy fixed link of the motion-plate. Box ends are used for the whole of the rods, and with oil cups worked in their webs.

Of the economies resulting from the use of superheated steam we cannot at present give data. There is on the side of water a saving of 10 per cent, which means less work on the boiler and less weight to haul up long inclines, of which many are of 1 in 40.

The engine proper is a two-cylinder compound. It works as a single-expansion locomotive whenever the cut-off exceeds 80 per cent. This is effected automatically by means of a live-steam pipe from the boiler to the low-pressure valve chest in connection with a four-way cock operated from the weigh-bar shaft. Ordinarily, without an intercepting valve in the receiver, the live steam introduced therein would set up back pressure against the high-pressure piston. The

COMPOUND GOODS LOCOMOTIVE, SAXONY STATE RAILWAYS.

curves are of 325 feet radius, the locomotives so constructed still having, as we learned recently, their original pivots and crank-pin bushes all in excellent condition.

This locomotive is notable as being the first of large power to which the system has been applied, its tractive effort being about 10½ tons, which is the full limit allowable for European railways operated under German conventions, the exceptions thereto being only rare cases where bank engines are always employed, and by which the conditions of safety affecting vehicle couplings are, of course, modified.

Two such experimental engines were put to work about three months ago—one with a serpentine superheater in the smoke-box, and the other minus this appendage—so that a very fair comparison of the working of the two engines will be contributed to our knowledge on this still debatable point.

Differing from a well-known system of superheater for locomotive boilers, and from yet others of which no description has ever been published, although already effecting an economy, it is claimed, of 13 per cent, the superheater of the Saxon locomotive does not depend for its economy in working upon heat abstracted from the fire-box—either by inside or outside flues—and with a consequent loss of a certain proportion of fire-box and tube heating surfaces, but is, on the contrary, a true economizer, absorbing as much as it is able to do of spent gases only. It has been argued that, without the localized reheating of the steam before entering the cylinders, an equal economy in thermal units could be effected by prolonging the tubes up to a length of, say, 19 feet, or 20 feet. It is, however, just this increase of weight entailed by a long boiler that renders such an extension impracticable in a country where the maximum weight allowed per axle is below 16 tons. Otherwise, a long boiler always signifies a large reservoir of latent passes direct to the high-pressure valve chest, and exhausts from the high-pressure cylinder into the receiver pipe, which continues around the left-hand—advancing—side of the smoke-box and near the top of which a breeches pipe divides the course of the steam, one part passing by a transverse pipe into the collector, and the other entering direct the left-hand collector. From these two longitudinal pipes the steam passes down through the battery of superheating coils screwed into the top side of the collecting pipes and into the sides of the corresponding distribution pipes at the bottom of the smoke-box, these latter being connected there by a transverse pipe, near to the left extremity of which a vertical pipe, with large conical mouth, descends to the low-pressure valve chest. At the front end of the smoke-box—not shown in the cross section—the six last bends of the superheater, in the top rows, almost meet from either side of the box. All the main steam pipes are at the back of the box, and all steam pipes and reheating coils leave the fire tubes unobstructed for sweeping.

No copper is used excepting for small pipes unconnected with the superheater. The main steam pipes are steel castings and the receiver pipe is of steel. The various inside diameters of pipes are: Steam pipe, 5½ inches; elbow, 5⅝ inches; receiver, 6¾ inches; superheater collectors and distributors, 5¼ inches; serpentines, 1½ inches; superheat steam pipe to low-pressure cylinder, 6¾ inches; blast, 8⅝ inches. When the engine is not working, steam leaks through a fine tube from the main steam reservoir into the breeches pipe and thence, of course, to the superheating coils.

Nothing special appears to be employed for the valves with this use of superheat steam. The slide valves with Allan steam-ports, and relieved according to the Fester (Chemnitz) system, are of crucible cast iron, as are all the valves of Saxon locomotives—bronze use of such an intercepting valve, always objectionable, is avoided here by the Lindner system of introducing live steam on both sides of the high-pressure piston, and so counteracting by this equalization of efforts the back pressure in the receiver. To do this there are two fine slits in the high pressure valve made in the flanges below its exhaust cavity, so that when the high-pressure valve is closed, these slits stand over the steam-ports in such a way that live steam, arriving under the valve from the receiver, passes at once to both sides of the high-pressure piston, until the working cut-off has been reduced. The locomotive is handled just like a single-expansion engine, and the device appears to be found practicable enough, since very many engines have been so fitted. However, in the newest patterns, as applied to 350 engines, including this locomotive, the end of the low-pressure slide-valve spindle extension in front is made to act as a very small steam slide valve only admitting steam to the low-pressure valve chest when the slide valve is at full travel, say, 80 per cent, as in starting a train. The slits or ports in the high-pressure valve remain necessary as before described, but the four-way cock is now in the newer pattern made to connect with the aforesaid sliding valve. This is explained by the longitudinal section. The starting valve connects with three live-steam pipes, one from the boiler, one to the middle length of the low-pressure cylinder, and one to the mid-length of the high-pressure cylinder on the inner side of each casting, as will be seen from the plan section of the locomotive. The effect accomplished by this introduction of auxiliary steam is that in certain crank positions when the low-pressure cylinder is about to make the start—the high-pressure valve being closed—steam enters at the middle of the high-pressure cylinder and drives the high-pressure piston, although its steam-ports have already been closed, and then at the opposite end of the

cylinder it escapes through a slit in the high-pressure valve flange, thence into the exhaust cavity onward to the receiver, and subsequently to the low-pressure cylinder, until the high-pressure valve in turn uncovers the exhaust passage in the usual manner—at which moment the high-pressure piston will have terminated its stroke. The engine is thus started promptly in spite of the unfavorable valve positions. One advantage of the other auxiliary steam pipe connecting to the middle of the low-pressure cylinder is that when the special starting valve has opened it to the receiver, all accidental leakage of steam occurring on the high-pressure side passes by the receiver direct into the low-pressure cylinder, the steam-ports of which are closed, and so it is utilized in driving the low-pressure piston, although its valves are shut and the piston is nearing the end of its stroke.—Engineer.

EXPERIMENTS SHOWING THE EFFICIENCY OF RADIATORS FOR GASOLINE AUTOMOBILES.*

THE capacity of a radiator to cool is fixed, depending upon the amount of radiating surface that it presents to the air. The capacity of a motor to heat is the variable matter. Every designer of a gasoline motor knows that a long red flame in explosion is a bad condition for heating, and that a motor with a small exhaust port, and consequent holding in of the hot gases—back-pressure so called—is apt to heat badly. He knows that thick walls, both of the explosion chamber and the water jacket, will also retain heat; in fact, he knows that speed, compression, exhaust, mixture, exposure, or position, and several other characteristics all have important bearing on the heating capacity of an explosion motor.

For the purpose of adding to the knowledge on this subject, an apparatus to test coolers was installed, and a series of tests were made, which, while made with extreme care, were limited by the conditions governing them, and the motor builder should bear these conditions in mind if he uses them for a basis for figuring out his own requirements. He must add or subtract what may be necessary when he compares with the conditions that confront him.

A 4½ by 6-inch single-cylinder motor, of the ordinary four-cycle type, was used to make the first of these tests, and is the basis from which the figures were taken, it being concluded that the results could be used as data with which to make comparisons for the larger sizes of motors. A jack shaft was connected to the motor corresponding to the rear axle. To this jack shaft was connected a fan through an intermediate counter shaft. This was done by the means of cone pulleys, in order that the speed of the fan could be varied. A pump of the ordinary positive or geared type was directly connected to the motor, so that it would at all times travel at the same speed. This pump had a capacity of 2 gallons per minute, with the engine running at 500 revolutions.

iron box or tube was brought to a square in such dimensions as would take in the largest cooler to be tested, and shutters were provided to close in around the cooler so that the entire volume of air induced by the blower would be drawn through the cooler.

The cooler to be tested was connected by the usual piping to the water tanks and the engine jacket. At or near the inlet and outlet of the radiator were attached feed water thermometers which showed the temperature of the water as it came from the water jacket and again after it had passed through the cooler. Thermometers were also provided to take the temperature of the air before it entered and after it had passed through the cooler. The whole apparatus was so arranged, it was thought, as to approximate as closely as possible actual road conditions.

The first series of tests consisted of taking five different sets of tubes, in reality five different coolers, containing respectively two, four, eight, ten, and twelve copper tubes of ⅝-inch outside diameter, each tube being 24 inches in length over all, and all put together with copper return bends of the same tubing. The two and four tubes were but one row in depth, while the eight, ten, and twelve tube sections were two rows deep. The tubes were No. 22 B. & S. gage, and each tube was entirely covered with 1¾-inch outside diameter copper fins or gills, spaced so as to give thirty-eight to the foot.

of heat as shown by the tests of the above coolers was taken as a basis, and it was found that, at 20 miles per hour, it was necessary to use 16 feet of ⅝-inch copper tubing, covered with 1¾-inch copper disks, the cooler to be mounted so that half the tubes would have front air exposure, in order to hold the water at a satisfactory working temperature—between 160 and 180 degrees—on the motor used. The average temperature of the entering air was 75 deg. F.

It will be noted that the eight-tube cooler held the water down to 164 deg. F., at which temperature it remained after 37 minutes' run, subsequent running at the same rate of speed and load failing to raise it above this. A measurement of the cylinder of this engine showed that it contained 76 square inches of heated surface, taking the cylinder wall under the water jacket casing as a basis for the measurement, and including the area of that part of the head which was water jacketed.

It therefore took to cool this 76 square inches of heated surface 16 feet of cooler as described, which contained 182 square inches of radiation to each foot in length, measuring the superficial area of the tubing and the fins. Therefore the entire length of tubing taken, 16 feet, equals a total of 2,912 square inches to cool 76 square inches of heated surface in the motor cylinder, or 38 square inches of radiation to each square inch of heated surface, at 20 miles per hour.

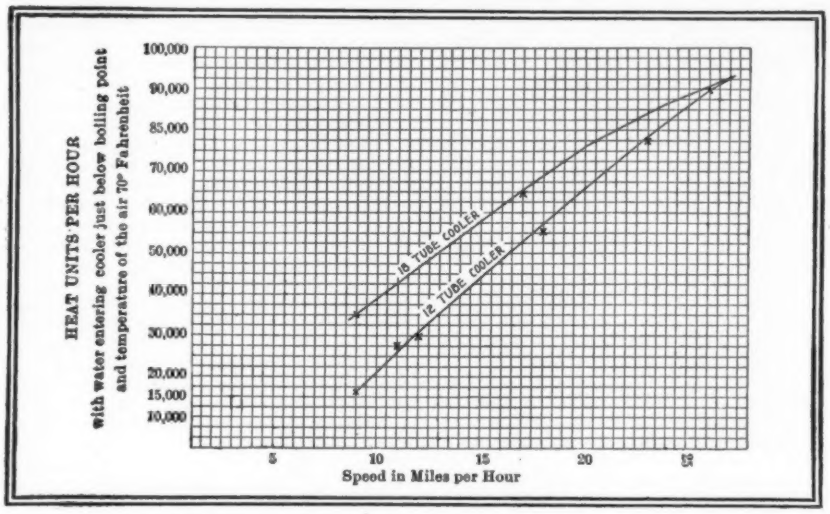


FIG. 2.—HEAT UNITS RADIATED BY TWO DIFFERENT LENGTHS OF TUBING WITH AN AIR BLAST OF FROM 8 TO 25 MILES AN HOUR.

Other results were deduced from the readings obtained with the apparatus. Similar temperature readings of the water entering the cooler were taken from the tests of the several sizes of coolers, and these readings were plotted as temperature curves, showing the relationship between the number of tubes in the cooler and the number of heat units radiated per hour at the different temperatures.

A diagram of these tests is given in Fig. 1 and shows the heat units—British thermal units—radiated per 24-inch lengths of copper tubing arranged as described. From the total cooling area of metal for this construction of cooler of 182 square inches of surface per foot of tubing, one can figure the number of heat units per square foot of cooling surface for any shape of tubular radiator covered by the curves. A heat unit is the quantity of heat required to raise the temperature of a pound of water 1 deg. F. Some such unit of measurement seems desirable because a reduction in temperature of a certain number of degrees means nothing in determining the size of a cooler unless the rate of circulation of water is given.

Each curve in Fig. 1 is marked in degrees Fahrenheit, showing the temperature at which the water from the engine jacket enters the cooler. The water circulation is at the rate of about 2 gallons per minute. The series of curves show to what extent the efficiency of different sizes of coolers is increased as the temperature of the inflowing water is raised. A cooler having 48 inches total length of tubing and receiving its hot water from the engine at a temperature of 150 degrees will radiate about 25,600 heat units per hour, with an approximate speed of 20 miles per hour. If the size of the cooler be doubled by connecting two tubes to it and the other conditions are kept the same, it will then radiate about 32,300 heat units per hour, or an increase of 25 per cent. Suppose, however, that the water is pumped to the cooler at 210 degrees, the smaller size will radiate 44,500, and the larger size, containing 8 feet, will radiate 6,300 heat units, this increase being over 40 per cent.

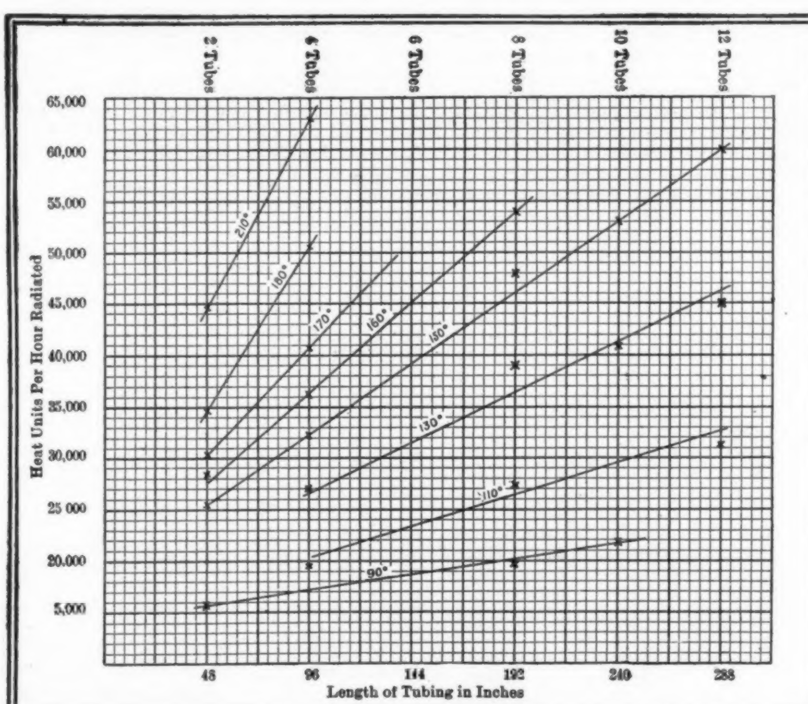


FIG. 1.—HEAT UNITS RADIATED BY DIFFERENT LENGTHS OF COPPER TUBING UNDER THE ACTION OF A 20-MILES-AN-HOUR BREEZE.

Mounted alongside of the engine was a box or tube, constructed of sheet iron, set into one end of which was a 21-inch A B C disk fan which was actuated by a jack shaft, the air thereby being drawn through the cooler and tube or box. A fifty-light dynamo was also connected with the jack shaft in order to provide for the steady running of the motor, the lamp board being so constructed that the load could be varied by throwing lamps in or out. The front end of the sheet

Water was taken in at an average temperature of 80 deg. F., and the following results were obtained:

Number tubes.	Length tubing.	Average maximum temperature.	Velocity of air in miles per hour.	Minutes to reach maximum temperature.
2	4 feet.	220 deg.	20	25
4	8 feet	210 deg.	20	37
8	16 feet	164 deg.	20	35
10	20 feet	150 deg.	20	39
12	24 feet	148 deg.	20	27

In order that a basis might be established by which a rule could be made, the capacity for the radiation

The tests summarize into the rule that with an air velocity of 20 miles per hour, 38 square inches of radiation in a tubular type radiator are necessary to cool 1 square inch of heated surface of the motor cylinder, with the pump delivering water to the radiator at a rate approximately of 2 gallons per minute, and with the temperature of the air as it would be on an average summer's day, and the speed 20 miles per hour.

In order to arrive at results from slower speeds, another series of tests were made, results of which are shown by the curves in Fig. 2, which show the relationship between the amount of radiation from an eighteen and a twelve-tube cooler, of the same length

* This article is the result of tests made under the supervision of William S. Conant, M. E., and Benjamin Briscoe, of the Briscoe Mfg. Co.

of tubes as described above, when the same amount of water at the same temperature is pumped through each. This is shown within the range of automobile speed of from 8 to 25 miles per hour. The efficiency of the cooler is, of course, dependent upon the surrounding temperature. These experiments are intended to represent average conditions of service; therefore, the air was drawn through the cooler at a constant temperature, warm but not hot.

The curves show how much more the water is cooled, in both a small and a large cooler, as the speed of the automobile, and consequently of the pump, is increased. This is as might be expected, as the cooler, passing rapidly through the air on an automobile, is acting under the conditions of an indirect hot water heater in a blower system, and elaborate tests with heating and ventilating engines have shown the improved efficiency of such heaters when the velocity of the air from the blower is increased.

When running at the comparatively high speed of 25 miles per hour, the curves indicate that the larger and the smaller tubular cooler, set up with the same hood, radiate practically the same amount of heat. At lower speeds, the larger cooler, however, shows its greater capacity for heat radiation and the consequent cooling of the jacket water.

When running at 8 miles per hour, the eighteen-tube cooler radiates more than twice as many heat units as the twelve-tube cooler. The action of the cooler under low speeds, with any given motor outfit, is evidently that which must determine its size.

The ideal conditions will be fulfilled when the size of tank and cooler on an automobile are such that the engine may be left running for an indefinite time while the machine is standing still on a hot day. To meet this condition it is but necessary to provide a circulating pump which, when pumping at the speed corresponding to the free running engine speed, will deliver the proper number of gallons per minute to keep the engine cylinder at a safe temperature. The temperature of the water pumped to the cylinder for such a determination should of course be about that found in service, or between 100 and 150 deg. F. If the cooler will keep the water from boiling under these conditions of rest, it will prove sufficient under any load. The air circulation when the machine is in motion will more than offset any increase of temperature in the cylinder.

In order to get a cooler which will keep the water at a temperature below the boiling point while the automobile is at rest but with the engine turning, it is of utmost importance to so place the cooler that it will have free upward circulation of air. Here again something can be learned from previous work on heating tests. The radiation from a direct steam coil, of the ordinary cast iron form, in still air, is diminished about 20 per cent when a flat board is laid over it so as to cover the top, although the four sides are left open.

An examination of the curves in Fig. 2 shows that at the different rates of speed a twelve-tube cooler will radiate heat units as follows:

25 miles per hour	90,000 heat units
20 miles per hour	70,000 heat units
15 miles per hour	49,000 heat units
10 miles per hour	25,500 heat units
8 miles per hour	17,000 heat units

Analyzing the above figures, it will be noted that a speed of 8 miles per hour will result in a radiator's having about one-fourth of the capacity that it would have at a speed of 20 miles per hour, thus proving that even in ordinary speeds and with pumps circulating to correspond with this, the capacity for radiation does not increase in direct proportion to the speed of the machine, but greatly exceeds it. It will be noted, moreover, in comparing the eighteen-tube curve, that the size of a cooler as it increases, gives a greater ratio of increase in its capacity for radiation than its larger size would demand.

Thus the tests show that an increase in the size of a radiator of 50 per cent would result in an increase of its capacity for radiation of over 100 per cent, at a speed of 8 miles per hour. Subsequent tests show further that when standing still a still greater difference will be manifested.

According to the first rule, a cooler traveling at a rate of 20 miles per hour must have 38 square inches of radiation to 1 inch of heated surface of the motor cylinder. It would of course be unsafe for a manufacturer of automobiles to design his cooler, based on a speed of 20 miles per hour; neither should it be expected that he would equip with a cooler that would be large enough to hold to a safe working temperature when the automobile was standing still, but the motor turning.

It would be reasonable, therefore, to select some intermediate speed, such as might be considered practical for the particular machine; for should a cooler be so large as to hold the water to a proper temperature at such a speed, at higher speeds it would take care of itself, and the risk of evaporation at slower speeds would be slight, as the times that the automobile would travel its slower speeds would be comparatively infrequent, and the probability is that higher speeds would follow alternately with low speeds, and therefore the increased efficiency at the high speeds would compensate for the decreased efficiency at the low speeds.

In order to provide for slower speeds, a careful analysis has been made of the tests taken, and it was found that the following amendment to the first rule will prove approximately correct to use for the average motor, the amendment being that for each mile less than 20 the automobile shall be intended to run—figured as its average working speed—it will be necessary to add 3 square inches of radiation to that given in the rule.

Supposing that a designer of automobiles should determine that his cooler ought to have a capacity sufficient to hold the water to a safe working temperature no higher than 180 degrees, with his machine running at 10 miles per hour, he can calculate for his cooler by adding 3 square inches of radiation for every mile less than 20, which in this case would be 10 miles or 30 square inches, to the figure already given as satisfactory at 20 miles per hour, 38 square inches. Therefore, 38 plus 30, or 68 square inches, would be sufficient to cool 1 square inch of heated cylinder surface at 10 miles per hour.

To reduce this to lineal measurement of a ⅝-inch tubular cooler, provided such cooler is made up with 1¾-inch copper fins, spaced thirty-eight to the foot, it will be found that 68-182 of a foot would give approximately 4½ lineal inches. To again reduce this to the amount required for any given cylinder, the total square inches of heated surface of the cylinder may be multiplied by this amount, which in the case of the motor used in making tests, would give approximately 28 feet. To prove this deduction, tests were made, using this quantity of tubing, and in no case with any combination of speeds, mixture, or load could the water be raised as it came from the cylinder to over 178 degrees under the most adverse circumstances.

A series of tests were made in order to compare the relative efficiency of copper and tin fins; also of fins soldered to tubes or not; of coolers coated with lamp black paint, or not so coated. These tests have been condensed into percentages with the following results:

A radiator with copper fins, painted and soldered, is the most efficient, and, as will be noted by the curves in Fig. 2, dissipates 70,000 heat units per hour at a speed of 20 miles per hour for a twelve-tube cooler. In order to condense the net results, let this combination be 100 per cent, and the following table is obtained:

Copper tubes with copper fins, soldered and coated.	100
Copper tubes with copper fins, not soldered but coated	70
Copper tubes with copper fins, not soldered and not coated	52
Copper tubes with tin fins, soldered and coated	58

It will be noted that tin fins soldered to the tubes and coated are more efficient than copper fins not coated and not soldered. It was further discovered that the efficiency of a radiator is materially increased by coating with black, and tests in this manner have also shown that a radiator can be coated with a dull lamp black paint or varnish up to as many as fourteen coats, and its efficiency will be slightly increased each coat. After that there is a diminishing in the efficiency. In practice, however, it is not found advantageous to dip them more than twice, one of the reasons being that the paint or varnish will adhere when given two coats better than when a greater number is given. It is essential, therefore, in any cooler to solder the fins of the tubes, thereby securing good conduction by its continuity. Also by coating the cooler black, thereby securing the greater radiating efficiency of a black surface for radiation; and thus by both of these operations aiding the other element which enters into the efficiency of radiators, that of convection.

By convection is meant a transfer, or the carrying away of the heat in a fluid mass, either of the air or of a liquid by means of the motion of the particles of that mass. Experiments made by others in order to ascertain some facts in reference to the transmission of heat have always proven that the rate of cooling by transmission of heat through metallic surfaces depends largely upon the rate of circulation of the cooling medium over the surface to be cooled.

A tube filled with hot water and moved by rapid rotation at the rate of 69 feet per second through the air in an experiment told of in Kent's Engineers' Pocket Book, lost as much heat in 1 minute as it did in still air in 12 minutes. In water at a velocity of 3 feet per second, as much heat was abstracted in half a minute as was abstracted in 1 minute when it was at rest in the water. It was found by Mr. Craddock, who made these tests, that the circulation of the cooling fluid became of the greatest importance as the difference in temperature on two sides of the plate became less. The results obtained by Pictet in reference to the loss due to direct radiation of different materials is as follows:

Red copper	0.16
Tin	0.21
Zinc	0.24
Polished brass	0.25
Polished silver	0.43
Polished sheet iron	0.45
Sheet lead	0.65
Ordinary sheet iron	2.77
Cast iron, new	3.17
Rusty sheet iron	3.36
Soot	4.01

The results as obtained above conclusively show, for instance, why the element of radiation is better served by coating red copper with a soot or lamp black paint, as the radiation of soot or lamp black is, as above noted, about twenty-five times that of copper. This does not apply, of course, to conductivity, which is another one of the important elements to be considered in coolers for automobiles. Conductivity of heat, through and by the different metals is as follows, taking silver, the best conductor, at 100:

Silver	100
Brass	24
Iron	12
Copper	74
Tin	15
German silver	6

This, therefore, conclusively shows why copper is the best material to use in radiators to serve the necessary element of conduction, silver being too expensive.

These conductivity figures do not mean as much, however, in the automobile cooler problem as they would seem to imply, because of the element of convection which also enters into it, which, as has been stated, implies the transfer of heat by the air surrounding the cooler, and as is demonstrated in the experiments of Mr. Craddock, convection depends on motion, it was attempted to work this out in the experiments and tests whereby the heat units extracted at various speeds, and the deductions therefrom, resulted.

It will be noted that all experiments heretofore noted in this article have been made with tubular coolers. Tests were made with various types of honeycomb coolers, and the results obtained show an efficiency no greater than the tubular type in proportion to the amount of radiation or surface exposed to the air, provided the tubes were ½ inch or less, and so arranged that the area of the water channel resulted in practically the same speed of the water through the cooler. This refers to the drop in temperature; that is, difference in the water in and out, but a further discovery was made, that the efficiency of the honeycomb cooler depended largely upon the rapid passing of water through it, it having to pass through oftener in a given length of time than through a tubular radiator in order to be as efficient.

A trial of honeycomb coolers should prove that if a tubular cooler is made with an area of capacity of water channel corresponding to a given type of honeycomb cooler, the efficiency of both will be practically the same.—Motor Age.

Correspondence.

BIRD FLIGHT AND MECHANICAL FLIGHT.

To the Editor of Scientific American Supplement:

I have read with much interest the correspondence in your admirable Supplement of April 23 on the "Flight of Birds and the Art of Flying." The record of Mr. Lancaster's observations on the flight of sandhill cranes is useful, but his remarks upon the motive power are open to much criticism. His scrappy and incomplete analysis, based on what he incorrectly terms "current methods," in no way warrants such a bold attack upon mechanical science as to state that "it stands in absolute imbecility when confronted with the observed facts of that of bird translation." Such a statement is absolutely absurd, since every observed fact of bird translation, which is not mere muscular effort, can be satisfactorily explained by the principles of natural philosophy. Perhaps Mr. Lancaster is not aware that *no* physical method of regarding the action of forces on a body denies the truth of Newton's third law of motion when properly interpreted. From his remarks it would seem that Mr. Lancaster has fallen into the same error with regard to the meaning of this law as do many metaphysicians and advocates of perpetual motion.

Newton in his Principia clearly shows that his third law does *not* apply merely to one body, but that the action of a body, A, on a body, B, is equal and opposite to the action of the body, B, on the body, A. Regarded in this light, I think Mr. Lancaster will see that the methods used by scientific men do harmonize with mechanical law, when properly understood. I quite agree with you, Mr. Editor, that the study of birds is most useful, but I do think that an observer like Mr. Lancaster should have better evidence to hand before attacking the ordered knowledge of the physicist.

For several years I have devoted much time to the study of bird flight in conjunction with numerous experiments with aerial gliders. From my observations and experiments I am convinced that the chief reason that migrating birds seek high elevations for their long journeys is not so much to obtain the diminished resistance of rarefied air—though this is important—but to meet with a suitable uprising current of air which counteracts the tendency of gravity to bring them to the earth, as they glide toward their destination.

Most probably birds such as the sandhill cranes, during a long flight, require to alter their altitude several times. This they do by flapping their wings and circling around until they suddenly meet with the proper uprising air-current, when they glide off at enormous speed on motionless wings. This explanation of soaring flight, viz., gliding in an uprising current, accounts for the birds exhibiting no trace of fatigue even after "coasting" long distances.

The recent valuable observations of the Brothers Wright also seem to confirm this explanation of soaring flight. I consider that the chief difficulty connected with the attempt to fly by means of a machine heavier than air is that of longitudinal stability—the tendency of the machine to turn over endways; and that once this difficulty is removed, the problem of artificial flight will be readily solved. The recent mathematical investigation of this subject by Dr. G. H. Bryan, Sc.D., F. R. S., and Mr. W. E. Williams, B.Sc., published in vol. 73 of the Proceedings of the Royal

Society, is well worth Mr. Lancaster's consideration, and will, I hope, cause him to think twice in future, before making absurd attacks upon the methods employed by scientific men. The paper I refer to shows that the longitudinal stability of aeroplane systems can be made the subject of mathematical calculation, and indeed it is of paramount importance that the methods employed by the authors should be practically applied to any aerial machines that may be designed or constructed before any actual glides are attempted.

W. H. CADMAN, B.Sc., F. C. S.
Member of the Aeronautical Society of Great Britain.

Sandymount Castle, Dublin, Ireland, May 2, 1904.

CONCERNING WIRELESS TELEGRAPH TRANSMITTERS.*

By LEE DE FOREST, Ph.D.

THROUGHOUT the various attempts which have been made to approximate in wireless telegraphy, even remotely, something of the accuracy in resonance effects so well known in acoustics, sufficient attention has not been shown to the necessity for generating at the transmitter a long train of but slightly-damped oscillations. All refinements and closeness of tuning at the receiving station are futile if the transmitter radiates but three or four impulses at each condenser discharge. Failure here has been largely due to imperfect arrangement and construction of condensers, spark-gap, faulty insulation, etc., in the transmitter, a condition inevitable at the start of a new art, when apparatus at hand is entirely such as the physics laboratory can supply, and when a host of minor details and refinements are neglected—conditions which alone distinguish between the experimental laboratory work and actual engineering achievement.

The rapid damping of the transmitter oscillations is due chiefly to two causes: First, that from losses due to radiation from the antenna (which are considered useful and necessary), and, second, to losses resulting from leakage, heat, and dielectric hysteresis, which are certainly detrimental to an extent little appreciated. Of leakage from the antenna, there will always be a certain amount. Thorough insulation, especially at top of the mast, and from all guy ropes, cannot be too strongly emphasized. If the antenna is connected to the resonator, or feeding circuit, inductively, whether by transformer or auto-transformer linking, the static potentials excited therein are slight compared to what result from the old method of attaching antenna and earth wires directly to opposite sides of the spark-gap. By the newer method, therefore, the problem of adequate insulation at the base of the antenna, where this enters the station house, is greatly simplified, for one may place his hand directly upon the bare antenna wire without shock or injury. At the top of the antenna, however, we have by the inductive connection with the resonator circuit, greatly amplified potentials, due to the fact that by such arrangement the oscillating character of the disturbance set up in the antenna causes a marked potential loop at the upper or open end of this oscillating wire; and by successive reflections of the current there, without change of sign, potentials several times those found anywhere in the closed oscillating circuit exist. As a result, the insulation at top must be especially thorough. A petticoat insulator, giving large and dry surface insulation, ought to intervene between antenna and its support. The layman is astonished at the facility with which these high-frequency, high-potential currents leak away, over surfaces carrying the slightest dust or moisture, or through the veins even of dry wood. Stone, even in dry weather, behaves like so much metal. Ebonite or glazed porcelain, or glass, are the best insulants here, and surface insulation is the controlling factor.

Mechanical reasons render it advisable to use steel guys for the mast, but if these be completely insulated from the antenna the leakage to them through damp air, and, indirectly, by currents induced in them, render it necessary to cut these guys into several short lengths, connected together by strain insulators (ropes with dead eyes or porcelains), and to most carefully insulate from earth at the bottom. In damp weather rope, especially if untarred, is but little better than wire.

If the air is moist or a heavy fog prevails, the invisible brush leakage from the antenna into this semi-conducting medium gives the effect of a large fictitious capacity between antenna and earth, greatly increasing its natural period of oscillation, and requiring readjustment of the constants of the closed resonator circuit, if it is intended to keep this and the antenna circuits in syntony. But worse than this is the fact that this apparent additional capacity is largely fictitious, and, as a leakage, represents a large hysteresis loss, not recoverable, but producing additional damping to the oscillation. The same phenomena exists, often to a greater degree, in the condensers themselves. In any Leyden jars or glass plate condensers in air, vivid brushes are observed extending for an inch or more at the edges of the tinfoil. At these portions of the glass, especially if this latter contain any lead, a surprising amount of heat is generated, showing clearly that considerable losses of energy there exist, and unless the glass is the best of flint, a further loss in dielectric hysteresis exists.

The glass condenser in air is generally preferred by experimenters for the very reason that these brush leakages, while they also cause an additional capacity over what ordinary static measurements will show, act as buffers for the impulsive high-potential charging of the condenser, and save the dielectric from puncture. It is well known that a Leyden jar filled with oil is far more liable to break down, and especially so if the outer coating also be covered with oil or paraffin. When the condenser is placed in an oscillating discharge circuit, containing inductance, the potentials developed at the edges of the tinfoil are often several times that of the charging current (due to heating up and reflection of the charges there from resonance effects), and this effect becomes greatly exaggerated with the oil condenser. But it is just this resonance which is a *sine qua non* in syntonic working, and it is wrong to allow brush leakage, with the great damping resulting, to save the dielectric. The correct practice calls for a suppression of all brush losses at every cost, and to employ oil, or condensers otherwise sealed, and sufficiently bulky, to give requisite safety with capacity.

Another bad element is the chain usually employed in the Leyden jar. After a little usage this becomes badly eaten up, frequent small sparks are observed between its links, and where it contacts with the tinfoil. I have sometimes known the chain to be actually burned in two. So aggravated do these faults of the Leyden jar become with much usage, that it is impossible to measure the period of oscillation of a circuit employing as condenser a battery of old jars. The foil frequently starts away from the glass, allowing all the losses and trouble from a gas dielectric. All in all, the time-honored Leyden jar, one of our dearest heirlooms from early physicists, is the element employed in wireless telegraphy which is least suited to its strength, convenience and cheapness when applied to small installations.

The amount of inductance existing in a battery of Leyden jars, when these are connected up as closely as possible, is surprising and little recognized. In fact, I may say that a condenser discharging aperiodically from lack of inductance in its discharge circuit does not exist. For high frequencies, the inductance in the sheets of foil themselves is sufficient, and the spark-gap and leads thereto supply the rest. In a battery of, say, ten Leyden jars connected in parallel, I have found that the exact method of connection is of the utmost importance. For example, if the ten be connected in one row the spark is not so violent, large, or of so cracking a sound as when the jars are bunched. The best arrangement is in a circle, with leads from all of the jars of exactly the same length. Otherwise, we get a tendency for a series of discharges from the several jars in turn, and not from the battery as a unit. Under certain conditions this little detail of grouping and connecting the jars has made all the difference in transmission of or failure to transmit signals. It is these little details of exact disposition of connections, etc., which are so apt to be overlooked by those familiar with ordinary electric currents, that have so grave an influence in wireless telegraphy, especially where syntony is attempted. The high-potential leads to the transformer or induction coil may sometimes have an influence on the oscillating circuit to which they are attached. To minimize the effect, choking coils, preferably of a spiral form, should be inserted in such leads close to the points of connection.

The heating of the spark-gap terminals, especially where alternating currents are employed for charging the condenser, is a simple proof of the losses existent in the spark. The wider the gap the greater the loss is through heating the column of air. A simple method of reducing this gap, while maintaining the requisite high potentials, is to employ a series of small gaps between balls or disks of small curvature. When large power is employed (exceeding 3 kilowatts) it is well to provide special means for radiating the heat, and constantly renewing the supply of cool unionized dielectric. There is nothing in a liquid dielectric, but considerable is to be said in favor of the spark in air under pressure, as reducing sparking distances and allowing an especially sudden, disruptive breakdown—a spark of high conductivity and slight damping.

With a 1-kilowatt transmitter it is easily possible to obtain a reading in a hot-wire ammeter, inserted in the antenna, of over 2 amperes, and five to ten times as much in the closed oscillating circuit itself. This, with 20,000 volts applied at the condenser jars, gives roughly a calculation of about 70 kilowatts. This anomaly is, of course, explained by Hertz's calculations of the amount of energy radiated from his small dumb-bell oscillator. During a brief hundredth-thousandth of a second the energy put into the circuit at a 1 kilowatt rate is radiated at a rate enormously greater. The exact quantitative relations here are difficult of measurement; they involve the exact potentials of resonance, the damping and duration of the wave-train, the power-factor, time-coefficient of expansion of the hot-wire, etc. But the test is a clear and convincing demonstration of the enormous quantities of energy which a small transmitter is radiating, and of the amount which the generator would be called on to supply could the much-desired undamped wave-train be obtained. It is evident that a direct-current source of high potential and relatively large output, with high-frequency oscillating circuit supplied as in the case of the Duddell singing arc, offers a solution.

In view of the above considerations it is not difficult to point out the fallacy in certain calculations which are often given to show the sensitiveness of a coherer or other wave detector, which is influenced at one hundred miles by one-half horse-power, or less, at the transmitter. Their sensitiveness is indeed remarkable, but if what such misleading figures seem at first sight to indicate, would be little less than infinite.

* London Electrician.

CONTEMPORARY ELECTRICAL SCIENCE.*

MAGNETIC MANGANESE ALLOYS.—F. Heusler has succeeded in producing magnetizable alloys of practically non-magnetic metals. He gives a number of data referring to castings of copper alloyed with manganese and aluminium in various proportions. The best results were obtained with a copper alloy containing 26.5 per cent of manganese and 14.6 per cent aluminium—i. e., manganese and aluminium in nearly atomic proportions. This alloy showed an induction of several thousand units in fields ranging from 20 to 150 units. It was considerably improved by keeping it at 110 deg. in boiling toluol for two days. The induction was then 4,500 units in a field of 10 units and 5,550 in a field of 150 units. When the percentage of aluminium was reduced to 3.6, the alloy ceased to be magnetic. Similar results, though not so good, were obtained with tin instead of aluminium. With one atom of tin to two of manganese there was practically no susceptibility. But an induction of 1,140 in a field of 100 units was obtained in copper containing one atom of tin to three of manganese. There was no iron present in either case, nor could similar results be obtained by introducing considerable iron impurities. The author points out an analogy with solutions of manganous nitrate, which have a higher molecular susceptibility than even the ferro-magnetic metals. Arsenic, antimony, bismuth and boron also yield magnetizable alloys.—F. Heusler, Verb. D. Physik. Ges., June 12, 1903.

MAGNETIC EXPANSION.—Outside the ferro-magnetic group of elements, bismuth has the largest susceptibility of any substance. It shows, however, no magnetic expansion or contraction, and the tacit assumption seems to have been made that, therefore, the still less susceptible metals will not show any either. But in the case of the ferro-magnetic metals there is no direct relation between the susceptibility and the change of length. Thus, iron has six times the maximum susceptibility of nickel, and yet expands far less for any known field. Again, cobalt has a maximum susceptibility one-eighth that of iron, but expands about as much. P. E. Shaw has, therefore, in a course of experiments covering nearly two years, looked for magnetic expansion in the less magnetic metals, including bismuth, silver, aluminium, copper, zinc, brass, bronze, lead and tin. At first the experiments, conducted with a simple form of electric micrometer, appeared to indicate that all the metals contracted to an extent proportional to the field, and that they all showed permanent magnetization on the hysteresis principle. But step by step these inferences were proved to be fallacious, as greater care was taken in the exclusion of iron from the apparatus and in the exact setting of the rod symmetrical in the coil and free from mechanical connection with it. The final conclusion reached was that no true expansion, positive or negative, can be detected within the limits of the experiment.—P. E. Shaw, Proc. Roy. Soc., June 18, 1903.

RADIO-ACTIVE GAS IN TAP WATER.—J. J. Thomson has found that when Cambridge tap-water is boiled, the air given off is mixed with a radio-active gas. The existence of this gas is easily demonstrated by electrical means, for if the air expelled by prolonged boiling from about 10 liters of water is introduced into a closed vessel whose volume is about 600 cubic centimeters, the amount of ionization in the vessel, as measured by the saturation current, is increased five or six times. A second boiling evolves no further radio-active gas. The gas can diffuse through a porous plate, and by comparing its rate of diffusion with that of CO_2 through the same plate, its density can be determined by Graham's law; preliminary measurements of this kind indicate that two different gases are present, of which one has a density about twice, the other between six or seven times that of CO_2. The gas obtained by boiling the water always diffused faster than that procured by bubbling air through the water; it seems possible that in the latter case the gas may be loaded with water vapor to a greater extent than in the former. At the temperature of liquid air the radio-active gas is frozen. A sample of 20 liters of the air was liquefied; the liquid was then allowed to boil away, the gas coming off at the commencement of boiling was collected, and also that coming off when the liquid had all but boiled away. On testing the samples for radio-activity the former was found to be slightly radio-active, but not nearly so much so as before liquefaction, while the second was extraordinarily radio-active, its activity being quite 30 times that of the original gas, thus showing, as we should expect from its great density, that the radio-active gas is much more easily liquefied than air. Similar radio-active specimens of air were obtained from various artesian wells as well as from the tap-water of Ely, Birmingham, and Ipswich, but not from surface water.—J. J. Thomson, Proc. Camb. Phil. Soc., October 21, 1903.

STORAGE OF N-RAYS.—R. Blondlot has made another remarkable discovery in connection with N-rays. He found that on concentrating N-rays with a quartz lens for some time upon a calcium screen and then taking away the Auer burner, the increased luminosity of the screen persisted as long as the quartz lens remained. The lens, in fact, possessed a kind of invisible N-ray phosphorescence. The same effect is shown by quartz plates, as well as Iceland spar, fluorspar, and glass. The reflective power of metals is, as we know, en-

* Compiled by E. E. Fournier d'Albe in the Electrician.

hanced by exposure to N-rays. This enhanced reflective power also persists for some 10 or 20 minutes. Lead becomes active in this manner on both faces if one of them is exposed to N-rays for several hours at a time. Aluminium, wood, paper, and paraffin do not store up N-rays, and the least trace of moisture completely eliminates the effect. Dry pebbles gathered in bright sunlight give out N-rays. The effect will be shown not to be quite analogous to phosphorescence in a further paper.—R. Blondlot, Comptes Rendus, November 9, 1903.

NOTES ON THE HERONS OF THE DISTRICT OF COLUMBIA.*

By PAUL BARTSCH.

THE extensive tidewater marshes bordering the two arms of the Potomac at Washington afford splendid feeding grounds for many of our birds, particularly the water birds and waders, and are doubtless responsible for the large number of the latter which visit the District of Columbia each season. Birds as large and beautiful as our herons are always conspicuous marks and must of necessity be shy to keep from serving as targets for the ever-present gunner. It is this habit, I am sure, which has led many persons to deem it necessary to visit secluded swamps, or even the subtropical everglades of Florida, to see herons in their native haunts, whereas a little search might reveal these wary members in their own locality where they may even rear their young.

No fewer than nine of the eighteen species which inhabit North America have been recorded within the limited area of the District of Columbia; four have been found breeding, and the great blue heron, which is with us in small numbers all the year, is strongly suspected of conducting his domestic affairs within our territory.

The most abundant member of the family is the black-crowned night heron (*Nycticorax nycticorax nævius*), or quak, as he is usually called by the untutored (Fig. 2). He is about 25 inches long, with bright-red eyes, black bill, and pale yellow legs and feet; the feathers of the crown are glossy greenish-black, except three long, narrow, white plumes which stream downward over the equally glossy greenish-black back; the forehead, neck, and median underparts are creamy-white, shading gradually to ashy on the sides, while the wings and tail are deep ash-gray.

Three colonies of these birds have their breeding grounds within the District and a fourth has been reported only a short distance beyond its limits. All of these are in small, dense pine coppices. In 1902 I visited two of these at various times while tenanted. In the latter part of April most of the nests, which were placed in the tops of slender pines, close to the center, twenty-five to forty feet from the ground, contained eggs. The nests [Fig. 3 (1)] are poor structures, mere platforms of dead twigs, somewhat depressed in the center and abundantly chalked with the excreta of the birds; they are so thin that the eggs could frequently be seen through them from the ground.

Night herons, as their name implies, are nocturnal in their habits. During the day all is quiet at the heronry. The males sit in the pines while the females pursue their task of incubation. Late in the afternoon, however, they leave the breeding grounds, flying in all directions to their favored hunting places. If disturbed during the day they will leave the trees with a few short, harsh quacks, sail about overhead for a while, then settle down quietly to watch the proceedings of the intruder. If the colony be invaded a little later when the large, light bluish-green eggs [Fig. 3 (2)] have delivered up their charge, the anxiety of the parents becomes more manifest and the birds leave the premises more reluctantly; in fact, it seems almost as if one had invaded a hen-roost, each bird shrieking and cackling as he or she leaves the nest or perch. Add to this the notes or calls of the young, and one has a fair notion of the din that greets him.

The young at birth [Fig. 3 (3)] are about as ugly birdlings as can be imagined; they are dark-skinned, wet, almost nude, with immense heads and large bills, quite out of proportion to the rest of the body, bearing a fairly strong, pointed knob at the tip which assisted them in breaking their egg-shell prisons. Weak and limp they lie stretched out in the middle of the nest. But a few hours bring wonderful changes. The wet down which clung closely to the body has become dried and fluffed up and the little birds are now enveloped in a coat of fine slaty-blue down. They even possess a decided head-crest of somewhat lighter color than the body-down, which gives to them a grotesque if not formidable appearance. Young herons grow very rapidly. Three days after hatching they are much increased in size, having considerably longer down and the first indication of pin feathers [Fig. 3 (4)]. By the end of the first week they are fairly bristling with pin-feathers and the feather-tracts have become strongly marked [Fig. 4 (1)]. On the tenth day [Fig. 4 (2)] many of the feather sheaths have become ruptured at the tips, and the birds begin to appear in their first plumage. About three weeks mark the termination of their stay in the nest [Fig. 4 (3)]; they are now almost as large as their parents, but quite differently colored, bearing still the little ivory tip at the point of the bill. Leaving the nest, they climb into the branches, a very praiseworthy act, for the old home and immediate surroundings have been thoroughly fouled by the combined wastes of the whole family, the nest, its supporting branches, and everything below it being completely whitewashed with the excreta of the birds, while undigested or dropped food adds to the disagreeableness of their old quarters. Then, too, from the branches they are better able to see the parents as they return from their foraging expeditions.

Young herons, though weak, have several methods of defense. When one climbs a tree in which the young have passed the second week, and the movements of the climbing begin to shake it, he may be sure to receive a contribution of whitewash from the various members. If the climber persists, the birds will even sacrifice their last meal in his favor, or rather disfavor, and a continuance of the climber's efforts will be met by the bird's final resort, which is to launch at the intruder with full force, spreading his wings and opening his cavernous mouth, striking with such violence that were he not securely anchored by his feet, he must surely be carried some distance beyond the nest. His fierce appearance and method of attack would repel any foe which might propose to dine upon his tender flesh.

By looking out over the tree-tops about the end of June, one may see many heron sentinels [Fig. 4 (4)] watching and waiting in the tips of trees. It is interesting to see how successfully these birds, built especially for the marsh, carry on arboreal life. The young, if disturbed when out in the branches, will, if old enough, either fly to a neighboring tree or climb rapidly from branch to branch. If they lose their balance in a jump, or fail to grasp a branch or twig with their toes, the bill comes to their aid; and I have seen birds suspended by their bills for some minutes, struggling all the while to reach the same twig with their toes, usually with success. A bird may even strike a branch with its neck, in which case this member is instantly crooked and serves as a hook to hold him until he regains his balance.

The feeding is all done at night, and it is interesting to be in the colony after sunset—such clamoring, such calling, such din! Everyone, no doubt, has heard the racket with which young crows greet their parents when they come with food. The heron's greeting is similar, only louder and more vociferous, if such be possible. All sorts of notes are heard, from the weak "pip, pip, pip, pip" of the tiny baby to the loud clucking of the parents, the latter reminding one strongly of the ejaculations of a sitting hen which has been suddenly dipped into a barrel of cold water and then released.

Fish seem to form the chief article of the heron's

1

2

FIGS. 1 AND 2.

1. Young Black-crowned Night Heron in full juvenile dress. 2. An adult.

2

1

FIG. 5.

1. Two young Green Herons 24 hours old and two addled eggs. 2. Twelve days old—on the defense.

* From Smithsonian Miscellaneous Publications.

diet, and the little yellow perch appears to contribute the largest share; at least this was the conclusion reached from an examination of the contributions and accidentally dropped material. I also noted several small eels, one small garter snake, and parts of frog skeletons, but no crayfish. The young are fed by regurgitation.

On June 1, 1902, I made a systematic survey of a colony of herons, the results of which are tabulated as follows:

COLONY I (JUNE 1, 1902).*

Nest No.	Eggs.	Young Birds 1	2	3	4	Empty.	Nest No.	Eggs.	Young Birds. 1	2	3	4	Empty.
1				n			40						?
2			nb				41				b		?
3				b			42						?
4					n		43						?
5				b			44						?
6					n		45					n	
7				nb			46						?
8			n				47						?
9						c	48						?
10				b			49						?
11						?	50						?
12						?	51						?
13						c	52						?
14						c	53						?
15						c	54						?
16						?	55						?
17						?	56						?
18						c	57						?
19						?	58						?
20						?	59						?
21						?	60						?
22						?	61					nt	
23						?	62						
24						?	63						
25				b			64						
26						?	65						
27					n		66						
28					nb		67						
29						?	68						
30				b			69	?					
31				b			70						
32					n		71						
33				n			72						
34						?	73						
35						?	74						
36						?	75						
37	4						76						
38				n									
39				b				4		2	12	7	30

Total nests examined ... 61
" eggs ... 4
" young birds (40 in nests, 28 on branches), 68

NOTE.—Nests numbered 62 to 76 were not examined, but if the same average number of young to the fourteen nests be allowed, this colony should have produced 88 young in 1902.

* In the above tables n = young in nests, b = young in branches, c = nest well chalked but empty, ? = empty without positive signs of having been occupied this season.

On June 19 an examination of another colony was made, the results of which are tabulated as follows:

COLONY II (JUNE 19, 1902).

Nest No.	Eggs.	Young Birds. 1	2	3	4	Empty.	Nest No.	Eggs.	Young Birds. 1	2	3	4	Empty.	Nest No.	Eggs.	Young Birds. 1	2	3	4	Empty.
1				nb			48				nb			95				n		
2				n			49						?	96				n		
3	4						50			n				97				n		
4				n			51				n			98				b		
5			n				52				b			99				b		
6						c	53				nb			100						?
7	4						54				b			101				b		
8					n		55						?	102					n	
9			n				56			b				103						?
10				n			57				nb			104		n				
11					n		58				nb			105						?
12				n			59				b			106				b	b	
13						?	60				b			107				b		
14							61				b			108						?
15						?	62				b			109						?
16				b			63				b			110						?
17				b			64			b				111				b		
18				b			65				nt			112				n		
19				b			66		b					113				b		
20		b					67				n			114						?
21	2						68					bn		115						?
22						c	69	1		n				116			b			
23				b			70		b					117			n			
24				b			71				b			118				b		
25		n					72			b				119				b		
26				b			73			b				120						?
27			b				74				b			121						?
28				n			75				b			122				b		
29						c	76				n			123				n		
30				n			77						?	124				n		
31				b			78				n			125				n		
32				nb			79		b					126			n			
33						c	80					b		127			b	b		
34						?	81				b			128				b		
35				b			82					n		129				b		
36				b			83				b			130						?
37				b			84		b					131			n			
38				n			85				b			132						?
39				n			86						?	133			b			
40				n			87						?	134						?
41				n			88						?	135				b		
42				b			89						?	136						?
43						c	90				b			137 to 177	?					
44				b			91						?							
45				b			92				b									
46			b				93				b									
47					b		94				b				11	7	15	74	8	29

Total nests examined ... 136
" eggs ... 11
" young birds (123 in nests, 170 in branches), 293

NOTE.—Nests numbered 137 to 177 were not examined, but if we allow the same average number of young to these forty-one nests, this colony should have produced 395 young in 1902.

There are still many unsolved problems about bird life, among which are the age that birds attain, the exact time at which some birds acquire their adult dress, and the changes which occur in this with years. Little, too, is known about the laws and routes of bird migration, and much less of the final disposition of the untold thousands which are annually produced.

When I visited the heron colony for the first time, it occurred to me that some light might be shed on one or more of these unsolved problems, at least so far as the present species is concerned, by marking the successive broods of young birds for a number of years. I explained the situation to Dr. F. W. True, head curator of biology in the National Museum, who agreed to procure the necessary bands. These were inscribed "Return to Smithsonian Institution," and bore the year and a serial number. Unfortunately no aluminium tubing of the desired caliber could be obtained at once, hence the bands arrived so late in the season that only twenty-three herons of the entire heronry were marked.

These bands are mere rings, of extremely light weight, large enough to fit comfortably about the tarsus of the adult bird. The fact that the bands are closed necessitates very early application, since the foot soon grows too large to permit the ring to slip over it. Once on, there is little danger of its ever being dislodged, for the heron's toes are always partly spread as he clings to the twigs of his nest. Only one return resulted from the 1902 marking of night herons; this was a specimen shot September 24, 1902, at Abington, Maryland, about fifty-five miles northeast of Washington.

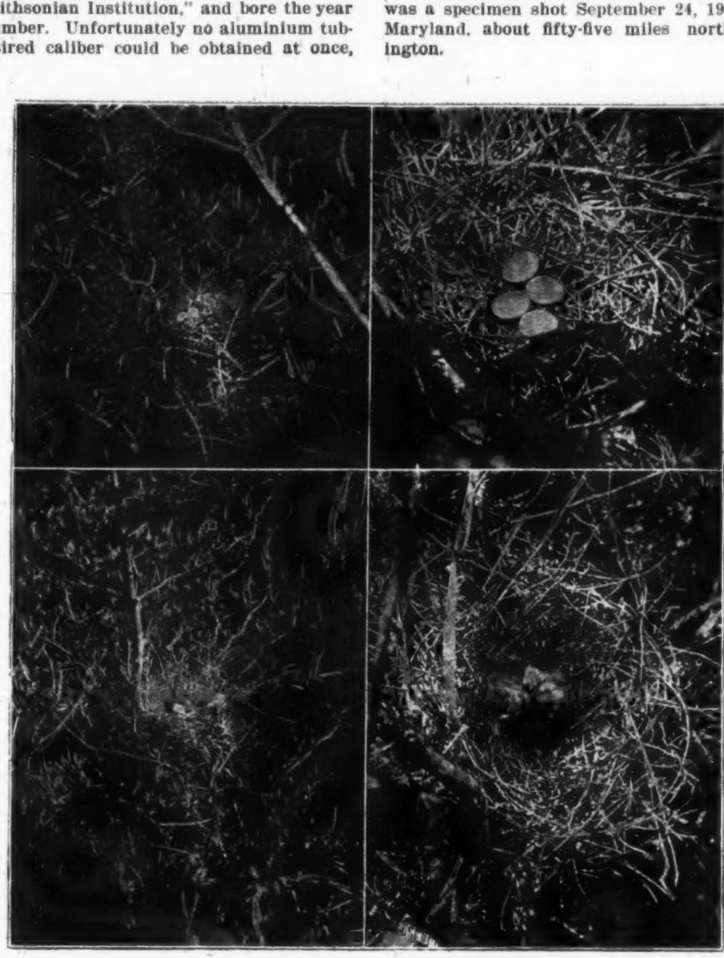


FIG. 3.

1. Nest and eggs of Black-crowned Night Heron in situ. 2. Detailed view of same. 3. Young and eggs of same, just hatched and hatching. 4. The young three days after hatching.

FIG. 4.

1. Young Black-crowned Night Herons seven days old. 2. Same, ten days old. 3. Same, three weeks old. 4. A favorite position in the tree-top after leaving the nest.

During the present year (1903) both colonies have changed quarters. One of the colonies selected an adjacent hillside, where eighty-nine nests have been counted. The location of the other is still unknown, since lack of time prevented a thorough search for it. No complete systematic survey was made of the known colony, which was in a mixed forest. All but seven

of the nests were placed in pines, the others in oaks. Four trees harbored two nests each.

Seventy-eight young birds were banded in 1903, five of which have already been heard from. The first was captured July 19 in a street in Leesburg, Va.; the second was caught July 20 in a fish-trap on the Potomac below Washington; the third was shot at Pennsville, New Jersey, July 18; while the fourth and fifth were found dead under the tree in which the young had been marked. The birds were almost full grown, and there are strong indications that the last two specimens had been stoned to death by ruthless boys before they left their nesting tree.

I visited this colony on August 10, and was surprised to find about a dozen large young present with their parents. These must have been a second brood, raised, perhaps, by the birds whose first nest had been plundered by some small boys after incubation was well advanced. In the preceding year (1902) a large number of the eggs were carried off from the smaller of the two colonies and the steps taken by many of those who were in a position to render aid should have prevented a similar occurrence.

The nearest relative of the black-crowned night heron is the yellow-crowned night heron (*Nyctinassa violacea*). Of the occurrence of this species in the District of Columbia there is but a single record—that of a juvenile individual, captured in the Smithsonian grounds, the skin of which is in the National Museum collection.

The remaining seven species listed for the District are diurnal waders and may be found feeding on the marshes and along creeks and lakes during the day. The most abundant of these is the little green heron (*Butorides virescens*), a bird of many names among the most common of which are shitepoke and fly-up-the-creek. He is not a sociable fellow, shunning company and rarely allowing other birds to feed or to build their homes near him. For a nesting site he chooses, like the night heron, a pine coppice and builds an equally flimsy nest on which the four pale-blue eggs are deposited. The young are even more downy than those of the night heron, and are altogether much more dainty and fluffy than the latter. Their color, too, is much softer, somewhat lighter and more bluish—almost maltese. Fig. 5 (1 and 2) shows the changes which took place in the same bird in twelve days.

It is interesting to watch this bird on his hunting ground as he moves stealthily along the shore, with indrawn neck, horizontally tilted body, and forward-pointed beak. If he espies a small fish or other object which may serve as food, he moves almost imperceptibly toward it, crouching lower and lower as he nears the victim, striking finally with such force that he appears fairly to lose his balance. This heron is not fond of wading, preferring to hunt along the shore or to seek his food by walking over the masses of aquatic vegetation which cover the Potomac to a great extent in summer and autumn.

The third species found breeding in the District of Columbia is the least bittern (*Ardetta exilis*). This is the smallest of our herons, and although with us every year from May to September, is seldom seen. His diminutive size and subdued coloration make him difficult to find, even in his favored haunts. One or two pairs breed annually in the cattail border which surrounds one of the fish-ponds near the Washington Monument. His large relative, the American bittern (*Botaurus lentiginosus*), occasionally spends the winter in the District, but is most abundant in the fall, when he is frequently flushed by the ortolan hunter and added to his bag of game.

Anacostia River, between Anacostia and Bennings, in the latter part of August fairly teems with bird life. Countless numbers of swallows find an abundant food supply on the marsh and an open field to train their wings for the long journey soon to be undertaken. This arm of the Potomac is at this season almost completely covered by wild rice and aquatic vegetation. The first covers completely the low mud flats and furnishes the thousands of sparrows, reed-birds, redwings, and ortolans with grain, while the latter forms a dense mat over all the water except the very narrow portion marking the channel. This green water-carpet is a favorite resort of the herons, and there may be seen the American egret (*Herodias egretta*), that large white heron second in size only to the great blue (*Ardea herodias*), which is also present, the little blue (*Florida cærulea*), and an occasional snowy heron (*Egretta candidissima*), all busily engaged in finding their daily food.

The most abundant of these is the little blue, although few would recognize him as such, for at the season referred to there may be at least fifty white birds (a color phase of this species) to one of dark color. Their food consists almost exclusively of crayfish, which at this season have the habit of flipping from the bottom of the shallow water to the surface of the floating vegetation, where they lie quiet for some time and fall an easy prey to the hungry heron. The little blue, like the green heron, seems to prefer walking to wading, though he is much more active than the latter species, flying up and down the marsh from one favorable feeding place to another. They are sociable birds, always fond of company.

The American egret and the great blue occur in about equal numbers. The former has been known to nest at Arlington Cemetery. Both are fishers, fond of wading, the great blue even more so than the egret. The latter frequently joins the little blues, when he appears as a giant of the same race. Among the host of white little blues there appears occasionally a bird, much more trim and graceful, whose yellow feet distinguish him at a glance from the other species. This is the snowy heron (*Egretta candidissima*), which is undoubtedly the most beautiful of all our waders, although it is quite rare in the District of Columbia.

As evening advances, the few night herons which remain go to the Anacostia marsh, while the diurnal members rise one after another and fly up the stream. I followed them one evening and found a secluded place on the bank, where the tops of several dead trees were fairly well surrounded and hidden by green vegetation. Here the herons had assembled in numbers and were preening their beautiful dresses, preparing for the night which was fast approaching.

THE DISLIKES OF ANIMALS.

NOT only is it true that animals, both domestic and wild, show decided preferences for certain persons, and a strong dislike to other individuals, but whole races of creatures often show a universal hatred toward other species. In the legends of ancient times this was noticed; always arrayed against each other were the otter and the crocodile, the hart and the dragon, the unicorn and the elephant.

Perhaps the most interesting cases of dislikes are those which are inherited, fear of the natural enemies of a certain weaker species being so strong that even the young just born may experience it. All herds of cows and cattle hate dogs instinctively. Can we not trace this to the time, long centuries ago, when the wild herds were always in danger of being attacked by wild dogs or wolves, which slunk about on the outskirts of the herd, and watched with hungry eyes every chance to cut out and pull down a helpless calf?

To fight like "cats and dogs" has become a proverb, and we must admit there is abundant basis for its truth. In domestic cats this is doubtless an inherited instinct, which in one of its larger relatives we can verify to-day. In India the tiger is king, almost. Deep in the jungles she makes her lair, and the cubs have few enemies, indeed. Bear or tiger-cat, when they inadvertently come across the lair trail of the great striped one, back-trail, and rapidly too. It is doubtful if even the great python would disturb one of the little, furry kittens. But the packs of wild dogs are without fear, and would kill and eat the cubs and defy the parent when she returned. Well she knows this, and also that although she might slay a dozen, yet the others would pin her down, ripping her flesh, careless if they died or no. So a tiger in captivity will scrutinize a wolf without much show of anger, but pity the dog that ever comes within reach, and if she cannot get at him, her wrath of memory will vent itself in howls and fierce endeavors on the bars of her cage.

A leopard, which lives so much among the trees and could so easily escape the attacks of wild dogs, has no instinctive hate, although a dog is a tidbit which would be by no means despised. This fact is well known to dogs, which show their fear of these arboreal felines, while they will mob tigers and other terrestrial cats. Pumas come under the same head as leopards, and are held in as great respect by dogs.

In zoos the animals generally show a dislike to children and cripples; in the first instance, doubtless, because they are teased more by the youngsters, and in the second place because of the strange horror and hate which many animals show of the abnormal, or conditions out of the usual, for discriminating between which they have remarkable ability.

Monkeys hate negroes, but this dislike of dark-skinned men is not confined only to the above mentioned class of animals. It is said that when Mr. Hagenbeck's Somalis were at the Crystal Palace they were invited one Sunday to see the zoo, whither they went, accompanied by Mr. Menzies, the African explorer and hunter whc had brought them from Somaliland. There was nothing to which the most sensitive European could object in the appearance of these free, half-Arab tribesmen, but when the dark men entered the lion house there was an uproar. The animals were furious; they roared with rage. The apes and monkeys were frightened and angry, the antelopes were alarmed, and even the phlegmatic wild cattle were excited. They recognized their natural enemies, the dark-skinned men who had hunted them for centuries in the jungles and the bush, and with whom their own parents did battle when they were captured and carried off captive in the Nubian deserts.

A bird will often die from sheer terror when greatly frightened, and parrots, emus, and monkeys will sometimes faint dead away. There are many cases of dislike or hate among animals which are inexplicable to us; just as many people have unreasonable but unconquerable prejudices against cats, mice, caterpillars, or snakes. Why, for instance, should camels arouse such disgust in horses? Bears and other animals are often unheeded by horses, but even the scent of a camel which has passed some time before is enough to make horses refuse to be driven near it. Horses will learn to work in company with elephants much sooner than with camels.

Even in animals which are nearly related to each other intense hatred sometimes exists. Hounds take delight in hunting foxes, and when dogs are used in pursuing and killing wolves they do it with a fierceness and anger which is never aroused in them at sight of the deer which they are running.

Animals, such as cats, dogs, birds, and even bees, seem to know what persons are in sympathy with them. Some persons will be attacked even by pigeons and doves, and it is impossible for some to have anything to do with horses and other animals.—N. Y. Evening Post.

RADIO-ACTIVE MINERALS AND SUBSTANCES.

THE United States Geological Survey is collecting information concerning the occurrence of radio-active minerals and substances in the United States. The minerals named in the appended list possess radio-active properties in various forms and degrees. Radio-activity has been noticed also in many substances which are not primarily minerals, such as slags, tail-

LIST OF MINERALS FOUND TO POSSESS RADIO-ACTIVE PROPERTIES.

MINERALS CONTAINING URANIUM.

Name.	Percentage of Uranium oxide contained.	Radio-activity (Curie's list), uranium unit 1.	No. in Dana's Mineralogy.
Uranothallite	35—37	....	307
Liebigite	36—38	....	308
Voglite	37	....	309
Thorite	1—10	0.7—2	395
Var. Uranothorite	....	....	....
Rowlandite	0.04	....	....
Uranophane	53—67	....	503
Hatchettolite	15—16	....	521
Fergusonite	1—3	0.1—0.4	523
Var. Tyrite	5—6	....	....
Var. Bragite	8—9	....	....
Sipylite	3—4	0.1—0.3	524
Yttrotantalite	1—2	....	528
Samarskite	....	1.1	....
Var. ——	9—16	....	529
Annerödite	16—17	....	530
Hielmite	2 5	....	531
Euxenite	5—12	....	534
Polycrase	5—20	....	535
Arrhenite	23—24	....	535½
Xenotime	0—4	0.03	536
Torbernite	57—62	....	659
Zeunerite	55—56	....	660
Autunite	55 62	2.7	661
Uranospinite	59—60	....	662
Uranocircite	56—57	....	663
Phosphuranylite	71—76	....	664
Trögerite	63—64	....	665
Walpurgite	20—21	....	666
Carnotite	62—65	....	....
Uraninite (Pitchblende)	75—85	1.6—8.3	711
Var. Broggerite	Vary in ratio of uranium oxides.	....	....
Var. Cleveite		....	....
Var. Nivenite		1.4	....
Var. Uranniobite		....	....
Gummite	61—75	....	712
Var. Thorogummite	....	....	....
Var. Yttrogummite	....	....	....
Mackintoshite	21—22	....	....
Uranosphærite	50—51	....	713
Johannite	67—68	....	806
Uranopilite	77—78	....	807

MINERALS CONTAINING THORIUM.*

Name.	Percentage of thorium oxide contained.	Radio-activity (Curie's list), uranium unit 1.
Tysonite	....	....
Fluocerite	....	....
Yttrocerite	....	....
Cassiterite	....	....
Var. Ainalite	....	....
Parisite	....	....
Bastnæsite	....	....
Lanthanite	....	....
Tengerite	....	....
Lavenite	....	....
Wohlerite	....	....
Eudialyte	....	....
Var. Eucolite	....	....
Cappelenite	....	....
Melanocerite	1—2	....
Caryocerite	13—14	....
Tritomite	8—9	....
Zircon	0—2	....
Var. Tachyaphaltite	Small amt.	....
Var. Cyrtolite	tr.	....
Thorite	48—72	0.7—2
Var. Auerlite	70	....
Var. Calciothorite	59—60	....
Var. Eucrasite	35—36	....
Var. Freyalite	28—29	....
Var. Orangite	71—72	2
Var. Uranothorite	52	....
Gadolinite	0—1	....
Var. Metagadolinite	....	....
Yttrialite	12	....
Thalenite	....	....
Allanite	....	....
Var. Bodenite	....	....
Var. Muromontite	....	....
Var. Orthite	....	....
Var. Uralorthite	....	....
Cerite	....	....
Cenosite	....	....
Keilhauite	....	....
Tscheffkinite	0—21	....
Johnstrupite	tr.	....
Mosandrite	tr.	....
Rinkite	....	....
Dysanalite	....	....
Pyrochlore	8	....
Hatchettolite	....	....
Microlite	....	....
Fergusonite	....	0.1—0.4
Var. Kochelite	1—2	....
Sipylite	....	0.1—0.3
Columbite (Tantalite)	....	0.02
Tapiolite	....	....
Skogbolite	....	....
Stibiotantalite	....	....
Mossite	....	....
Yttrotantalite	....	....
Samarskite	....	1.1
Var. from Colorado	3—4	....
Annerödite	2—3	....
Hielmite	....	....
Aeschynite	15—17	0.7
Polymignite	3—4	....
Zirkelite	7—8	....
Euxenite	0—6	....
Polycrase	3—4	....
Arrhenite	....	....
Rogersite	....	....
Xenotime	0—3	0.03
Monazite	0—18	0.5
Rhabdophanite	....	....
Churchite	....	....
Uraninite (Pitchblende)	0—10	1.6—8.3
Var. Broggerite	5—6	....
Var. Cleveite	3—5	1.4
Var. Nivenite	6—8	....
Var. Uranniobate	....	....
Gummite	(0—42)	....
Var. Thorogummite	41—42	....
Var. Yttrogummite	0—?	....
Mackintoshite	45—46	....

* It has been pretty well established that thoria is not radio-active unless the mineral in which it is found contains uranium also.

ings from concentrators, slimes, chemical wastes, natural mineral waters, deep-well waters, and petroleum, and it is possible that the list of radio-active minerals and substances may be greatly increased.

The simplest means of detecting radio-activity in a substance is by the use of a photographic plate. The more sensitive the plate the better. The plate should not be removed from the inclosing black paper, and a metal object should be laid upon this black paper in a dark room; upon this should be placed the specimen to be tested. Instead of the metal object a few small nails may be arranged so as to form the initial of the owner and left on the paper-covered plate below the specimen. The specimen should be left in the dark room for from two to fifteen hours and then developed in the usual manner. If the specimen has radio-active powers, a photograph of the metal object or of the nail-formed initial will be produced on the plate exactly as if it had been exposed to the sun's rays. The test should be made, if possible, with from half a pound to a pound of the material. The electrical method is more reliable, but is much more difficult.

ELEMENTS AND COMPOUNDS.

To the engineer who refrains from philosophizing, the distinction between elements and compounds appears simple enough. A substance is elementary when all its particles show the same properties, and when no mechanical, physical, or chemical treatment can separate from it any particle differing from the others. The metals are elements, their alloys compounds. In practice, we do not know any substance which is absolutely homogeneous; it is, we say, because no substance is quite pure. Impurities are considered as alien—something foreign to the substance. That is, we prescribe ideal conditions for the elements with as much, or as little, right as we lay down the law for perfect gases. We all retain a lurking conviction that there is, after all, only one kind of matter, and that its properties change with the conditions. Would it not be more consistent formally to admit that the only difference between elements and compounds consists in the supposed impossibility of proving the so-called elements to be compounds.

This question was answered in the affirmative in the Faraday lecture which Prof. W. Ostwald, of Leipzig, delivered before the Chemical Society on Tuesday, April 19. The lectures are given in the hall of the Royal Institution, where Faraday taught; and the invitation to address the society from Faraday's chair, and to accept the Faraday medal, is an honor that Prof. Ostwald has shared with the great men Dumas, Cannizzaro, A. W. Hofmann, Wurtz, Helmholz, Mendeleieff, and Rayleigh. Prof. Ostwald is, perhaps, in a more direct sense than any other of his predecessors, a pupil of Faraday, though he never saw him. The word "ion," which may be said to stand foremost in Ostwald's creed, was uttered for the first time, in its modern sense, by Faraday; the problems of catalysis, to which Ostwald has devoted much study, came under Faraday's hands; and Ostwald's energetics led him to the conclusion which Faraday, coming back to the standpoint of Boscovich, expressed by saying that the atoms are only mathematical points whence the forces emerge, or where the directions of several forces intersect.

It is from this standpoint that Prof. Ostwald dealt with the theme—Elements and Compounds. Born in the Baltic provinces of Russia, he studied and taught at Riga and Dorpat before he accepted a call to Leipzig, where he soon gathered around him a school of physical chemists, who look up to him as to one of the fathers of modern electro-chemistry. Nothing of this is to be found in his lecture. There is not a table, not an atomic weight, not a coefficient, not even an allusion to modern electro-chemistry to be found in it. It is an outline of bold novel conceptions, in an original garb, based upon chemical dynamics, without any electrical support. It may be interesting to the engineer that in one of his chief tasks and arguments, Prof. Ostwald was guided by the ideas of a metallurgist, Franz Wald, the chief chemist of the Kladno Iron Works, in Bohemia—a man who has, so far, met with little recognition. It is possible, Prof. Ostwald stated in the opening of his lecture, to deduce from the principles of chemical dynamics all the stoichiometrical laws: The laws of constant proportions, of multiple proportions, of combining weights. That this was possible had been denied by all investigators, until Franz Wald first gave the proof. To make this assertion means to step on somewhat volcanic ground; Prof. Ostwald was quite aware of that. He is prepared for severe criticism, and he will receive it. For to the majority of the chemists, Dalton's atomic hypothesis in its modern form is a theory. But the various radiations that have been demonstrated of late have cast strange lights on many subjects, and we need to suspend judgment until we gain clearer views.

Prof. Ostwald starts from equilibrium. We have equilibrium when the forces balance one another, so that no motion ensues, or where no variation occurs in the properties of the system; in the most general sense, equilibrium denotes a state independent of time. To attain equilibrium, temperature and pressure, and, therefore, volume and entropy, must remain constant; and that is only possible in a homogeneous system. Solutions or gaseous mixtures, of different concentrations at different spots, are not homogeneous. In water in contact with water vapor we have two different states without homogeneity. Here we are introduced to the new concept of Willard Gibbs, a phase in which the temperature and pressure are the same everywhere, but the specific volume and specific entropy change from one body to another. The phase may be distributed over any number of parts. The millions of globules of butter in milk form one phase, the watery solution of casein and milk sugar forms another; milk is a two-phase system. Excluding gravitation, electricity, surface tension, etc., and considering only heat and volume energy as the sole forms of energy involved, we may say that every system consisting of only one phase has two degrees of freedom. That would apply both to an elementary gas like oxygen, and to a mixture of whisky and water, which can only change in pressure and temperature. Every one-phase system has a limited sphere of existence; the solid or liquid may with lowered pressure pass into the gaseous state. The sphere need not be limited on all sides, however; there is apparently no limit on the side of low pressure and high temperature for gases; for solids not on the side of high pressure and low temperature. But if we exceed the limits of existence of a phase, a new phase will be formed. The boundary lines between the different phases represent the interdependent values of temperature and pressure for the possibility of the coexistence of the two phases. By admitting this coexistence we lose one degree of freedom, and we introduce the ratio between the masses of the two phases.

As a rule, the properties of both the phases will change during the transformation of one phase into another. When we evaporate sea water at constant temperature, the density of the residue grows continually higher, while the pressure—and therefore the density of the vapor—goes on decreasing. When we evaporate distilled water, the properties of the residue and of the vapor remain unchanged during the whole transmutation. Bodies of the first description we call solutions, bodies of the second class hylotropic bodies. We might call the latter chemical individuals or substances; but the term "hylotropic" body is broader. Graphically represented, with temperature or pressure as ordinate, and the portion of the first phase converted into the second as abscissa, the hylotropic body gives a straight horizontal line; the solution yields also a continuous line which will not be horizontal, however, and, as a rule, is curved. If the ordinates mean pressure at constant temperature, and the change is from liquid into vapor, the curve will slope downward. At higher temperatures we get similar curves above the first curve. In any case the residue will always be less volatile, and the distillate more volatile, than the original solution. There need not be any end to this separation by continued distillation. But practically we shall come to a limit of volatility on both sides, which signifies that every solution can be resolved into two or more components which are hylotropic bodies. Thus we arrive at a relation between the properties of a solution and the nature and proportion of its hylotropic components.

The boiling points of all solutions formed by two hylotropic components yield us three types of curves. The curve may rise continually, or it may have a maximum boiling point, or a minimum, at some spot. The solution corresponding to that point—the distinguishing point of Willard Gibbs and of Konovaloff—must behave as a hylotropic body, though it is a mixture. This seems to contradict what was said above. But if we trace a series of boiling-point curves for different pressures, the distinguishing points may either lie on the same vertical, or they may not; in the latter case, the distinguishing point will shift to the right or left as the pressure varies. In the first instance, when the points lie all on the same vertical, the hylotropic body will be a chemical individual or a substance in Ostwald's sense; not an element, of course. A substance in this meaning is a compound or solution, such that the ratio between the components is independent of temperature and pressure—between certain limits. But this is essentially the law of definite proportions, the first of the stoichiometrical laws; and if we grant that much, we can deduce the laws of multiple proportions, and of combining weights. The deduction sounds a little like arguing in a circle, we must confess; but the matter has to be studied.

We just made the reservation, "between certain limits." If we exceed the limits of pressure and temperature, within which the body behaves as hylotropic, then the body will assume the properties of a solution whose distinguishing point shifts as the temperature changes. It becomes possible then to separate the body into its components; and we call this state the state of dissociation of the substance in question. Most substances, of course, behave in this way. But we know substances which have never been transformed into solutions, and whose sphere of existence covers all accessible states of temperature and pressure; such substances we style elements, and they are now defined as substances which never form other than hylotropic phases. As now the relation between a compound substance and its elements admits of one qualitative and quantitative interpretation only, we must always, in resolving a substance, come to the same elements in the same proportions—the conservation of the elements.

We have not gained much by this roundabout way of explaining what we all understood before, it may be objected. But it is a most suggestive way of approaching problems which confront us. How are we to picture elements to ourselves, however, on this ground? For Prof. Ostwald, matter is only a complex of energies, which we find together in the same place. It may fill the space homogeneously, or in a periodic or grained manner. If we adhere to the grains, we have a substitute for the atomic hypothesis. The decision between the hypotheses is a purely experimental question. Many facts, including chemical facts, certainly can be described by a homogeneous or non-periodic distribution of energy in space. Then comes the question: What energetic properties underlie the concept of a chemical individual? What renders it possible for us to isolate a substance from a solution is that the available energy of the substance is a minimum, compared with that of all adjacent bodies. A minimum of vapor pressure is always accompanied by a minimum of available energy, and is also the characteristic of a hylotropic body. The differences between the several substances are connected with the differences in their specific energy content, such as specific volume and specific entropy, which we cannot change at will, while temperature and pressure can be changed at will. There may be more than these two characteristics of different subjects; Prof. Ostwald did not follow that issue up. Take these two characteristics for a system of planar co-ordinates; then the elements will be single points in the plane. We raise ordinates from these points representing the available energy of each element. Between the points (of the elements) in the plane will be situated the points of all possible solutions, each of which will have its available energy, and the corresponding points in space will form a continuous surface. As now each element has its point in a relative minimum, the surface as a whole will have the shape of the ceiling of a cavern from which stalactites are hanging down; the end of each stalactite represents an element.

How can we pass from one element to another? Only by going up the stalactite *via* the higher parts of the surface. If we imagine a drop of water at the end of one stalactite as representative of the element, then we should have to make that water travel up the stalactite, and descend another, in order to pass into the state of that second element. This can only be accomplished by accumulating an appropriate amount of available energy in the element to be changed, but that cannot be pushed *ad libitum*. We cannot compress a gas nor concentrate electricity beyond a certain pressure; the metals would flow, and the insulation break down; and thus we cannot transmute the elements, because we cannot concentrate sufficient energy. These last embryonic considerations were not suggested to the lecturer by the transmutation of radium into helium. Prof. Ostwald expressed such views some years ago to Sir W. Ramsay; but without the now more or less accepted experimental change of radium into helium, he would not have brought these matters before the meeting. We have to see how this accomplished transmutation fits into his hypothesis. As the atomic weights become higher and higher, the stalactites from the ceiling become shorter, until they form simply different slopes in the ceiling. The drop of water could pass round the corners of these slopes. It is an exceedingly bold, not to say fanciful, simile. But, at any rate, it would be compatible with the enormous amount of free energy with which we have to credit radium, which seems to be capable of giving out heat under all conditions; and the circumstance that elements like radium appear to have only a temporary existence, while the resulting helium is a most sluggish body—a very long stalactite—would not controvert this view.

The many rays and radiations emanating from radium may represent other intermediate forms of energy leading to the formation of other temporary elements which we have, so far, been unable to fix, and which we may not succeed in fixing. For the concentration of high energy for long periods offers very great difficulties; it is a question, for instance, whether a pressure of several thousand volts could be maintained for months.

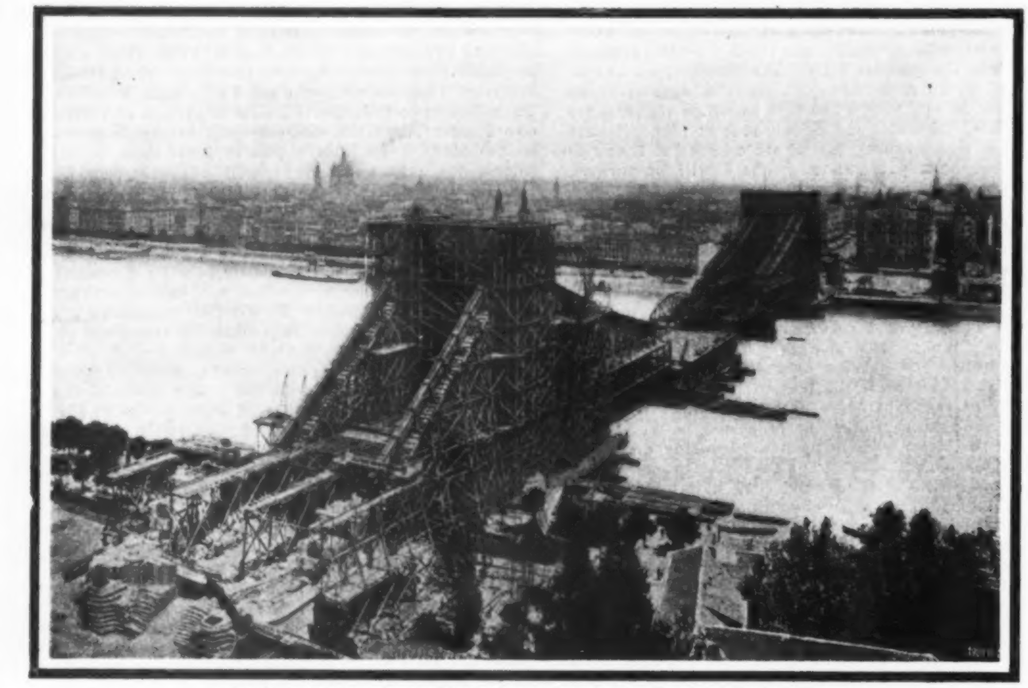
This is briefly the essence of Prof. Ostwald's lecture. He does not deceive himself concerning the strength of his arguments. "Such suggestions are questions put to Nature. If she says 'Yes,' then we may follow the path a little further. If she says 'No,' then we must try another path." We may join in the hearty applause which the large audience accorded to the lecturer on the invitation of the president of the Chemical Society, Prof. Tilden, and of Profs. Dewar, Thorpe, and Lord Rayleigh, and we may yet maintain an attitude of appreciative reserve. We are not all convinced of the transmutation of radium into helium. The atomic theory has done splendid service, and will continue to do so; so have the theses on modern electro-chemistry advocated by Prof. Ostwald. The peep into his mysterious energy cavern is fascinating; but the cavern needs a great deal of light, as Prof. Dewar put it. We cannot conclude more appropriately than with Lord Rayleigh's remarks: "We have just tried to pick up a few of Prof. Ostwald's ideas, at least by their tails. Twenty or thirty years ago, we thought that we understood the course of nature—at any rate, in the rough—looking to the future for the elucidation of details. We are more modest now. We recognize that we may have to face a revolution."—Engineering.

MODERN RELIGIOUS CEREMONIES OF THE HINDOOS.

SOME interesting information respecting the curious religious customs of the Hindoo population is furnished in the report on the 1901 census of British India. One of the most remarkable of these observances is that of the orderlies from the hills round Simla, who every year accompany the government to Calcutta. At the time of the spring equinox there is a fetish festival called "Sri Panchami," when every religious-minded person worships the implements or insignia of the vocation by which he gains his livelihood. The Thugs had a picturesque ritual for adoring the pickaxe with which they dug the graves of their

victims; and, to cite the most modern instance, the operatives in the jute mills near Calcutta bow down to the engines which drive their looms.

According to the writer who describes this festival the ceremony took place on the flat roof of the huge pile of buildings which are occupied by the secretariats of the government of India. The worshipers, some thirty in number, engaged as their priest a Punjabi Brahmin, who was employed in the same capacity as themselves. They took one of the large packing cases which are used to convey office records from Simla to Calcutta and draped its rough woodwork with plantain leaves and branches of the sacred pipal tree. On this foundation, they set up a sort of altar fashioned from a dispatch box; in the center of the altar was placed as the principal fetish a common English glass inkpot, with a screw top, and round this were arranged the various sorts of stationery in common use—penholders and pen-nibs, pencils, red, blue, and black; penknives, ink erasers, foolscap and letter paper, envelopes, postage stamps, blotting paper, sealing wax—in short, all the clerkly paraphernalia by which the government of India carries on its work. The whole was festooned with abundant coils of red tape. Offerings of food were made to this extraordinary composite deity, and the Brahmin recited various cabalistic formulæ, supposed to be texts from the Vedas, of which neither he nor the worshipers understood a single word.



THE BUDA-PEST BRIDGE IN COURSE OF CONSTRUCTION.

THE ELIZABETH BRIDGE, BUDA-PEST.—II.*

The superstructure of the bridge was built at the large bridge shops of the State Railways at Buda-Pest. The towers, which, when united, form the portals at either end of the bridge, are themselves composed of two sections.

The preparation of the foundations had been in progress since 1897, and in the autumn of 1899 the heavy steel work of the anchorages was built into the anchor chambers. The chain anchorages consist of massive ribbed shoes, two for each of the two chains in one anchorage chamber, these steel castings, weighing each about 6¾ tons, being solidly stayed together with deep I-section girders and with the curved bearing surface of the shoes canted in toward the center line of the chain. The bellied anchor beams, two to each chain, are 2.565 meters in length between shoe centers, and have a greatest depth of 1.200 meters at their middle, and a thickness of 290 millimeters. To these are bolted spherical-backed regulating wedges, which transmit the pressure to the curved bearings of the shoe. Our view, Fig. 2, representing the anchor chamber as seen looking toward the bridge, shows the upper anchor-beam belonging to the lower chain during the operation of securing the regulating wedges. At this time, in the autumn of 1899, the chain erection had not been commenced. Fig. 4 shows details of the anchorage.

* No. I. appeared in last week's Supplement.

The principal dimensions of the structure, at a presumed temperature of 10 deg. Cent., are here grouped together:

Total length of bridge between abutments	374.4 m.
Shore spans—center of line to face of anchorage abutments	42.2 m.
River span	290.0 m.
Roadway breadth	11.00 m.
Sidewalks (two) in middle span, width	3.5 m.
Sidewalks in approach spans, width	3.7 m.
Grade of roadway, rising to center on each side	27 per cent
Length of parabolic truss in middle of bridge	100 m.
Height of road surface above mean water level, without live loads at middle	18.575 m.
Height of road surface above mean water level, without live loads at sides above piers	15.335 m.
Sidewalk—height above roadway gutters	195 mm.
Cant of road toward either footwalk	1 in 40
Cant of promenades to road	1 in 70
Distance transversely between the center lines of chains	20 m.
Point of suspension of upper chain above mean water and with dead load	51.56 m.
Point of suspension of lower chain above mean water and with dead load	50.04 m.
Distance vertically between points of suspension in the same tower	1.52 m.
Deflection of catenary line at mid-span	22.56 m.
Distance vertically between center lines of main chains	1.338 m
Distance vertically between center of anchor-eyes of the chains	2.64 m.
Upper chain—height of anchor-eye above mean water level	1.79 m.
Lower chain—distance of anchor-eye below mean water level	0.39 m.
Suspension pins—horizontal distance between centers, tower to tower	290.00 m.
Horizontal distance, suspension pins to anchor-eyes—upper chain	69.244 m.
Horizontal distance, suspension pins to anchor-eyes—lower chain	67.755 m.
Horizontal distance, anchor to anchor	428.488 m.

Although the anchorage foundations on either side of the Danube were begun simultaneously, some interruption occurred to the regular progress of the work on one side through infiltrations from a hot spring on the right-hand bank (Buda side). To guard against this, a thick course of waterproofing material was laid in the foundations and also over the sides of the anchorage piers. When the masonry of the piers and anchorage piers was sufficiently advanced, the working bases for the structure were aligned and leveled from fixed points in the masonry, and the exact distance between the fixed points on either bank was determined by triangulations, effected by the Danube Bridges Constructional Departments.

The overhanging abutments, or imposts for the anchorage, had to be built with particular accuracy in their setting at the various angles required in relation to the different catenary lines, and this was effected by means of templets erected on stoolings in the anchor chamber. For the work of setting the anchor shoes in place, the traveling crane, which had served for the masonry, was again employed, and these masses of steel were then underpinned by posts, pending the later erection of the main suspension cables, but in such manner as to leave the fullest room possible for the erection of the anchor chains and for subsequent operations of adjusting the anchor shoe regulating wedges for truss alignments. This work was done with the vault of the chamber open, and the anchor chain gallery was likewise kept open during the erection of those links by which it is traversed, and up to certain stages of advancement to be noticed in the different views given.

Following immediately upon the fixture of the anchor thrust blocks or shoes, the lowest links in the lower anchor chains—chain eyes Nos. 1 and 2—were erected upon timber stoolings, with the anchor stop plates threaded between every alternate link, and onto these were screwed the angular filling plates, which, along with the stop plates, take the thrust against the forged steel double anchor beams. The corresponding links of the upper chain were next erected, and this permitted the completion of all the principal work in the anchor chamber, which, due to causes already mentioned, was first done on the Pest shore. The forms of timber stoolings which were employed throughout the work, and in general the method of assembling eye-bars in the field, are shown in the accompanying view—Fig. 3—which represents the erection of the links of the upper chain between eyes 2 to 3, at midlength in the chain gallery on the right-hand—Buda—bank. Each plate lowered into the gallery was so suspended from the crane chains as to drop in parallel with the others already assembled, and as in this operation the lower head of the link butted against a cross timber, this latter insured the approximate centering of each eye ready for the passage of the pin, which appears to have sometimes required a certain amount of driving—in this case effected by means of a beam slung by two ropes—the extent of each feed being, of course, the thickness of each plate—namely, 25 millimeters.

In the upper sections, as the work progressed, the lower chains were supported under each head by sleep-

Fig. 2.—ANCHOR CHAMBER.

Fig. 3.—ASSEMBLING EYE-BARS.

ers resting upon the false works, and the upper chains by buttressed stoolings, all supports being adjustable by means of oak wedges for the vertical and transverse alignment of the eye-bars. When the timbers had been wedged, a third stool was erected under the middle length of each of the upper chain bars, and to this, but upon the upper edges of the links, light framed struts, bolted along the upper half of the bar, aided in the work of setting the lower heads of the next succeeding chain plates. This work of chain erection was carried on up to the fourth eyes—that is, on a line with the upper chords of the shore truss—when the work ceased for a time, October, 1899, and the upper heads were clothed in waterproof sheeting to protect them from the weather while work was being advanced on the superstructure. A drawing of the eye-bars is given in Fig. 5.

Superstructure.—The first preliminary work for the towers was the setting of the four pivot pedestals on each of the piers. These steel castings, each weighing 15¼ tons, were adjusted in pairs, with their axes in absolute alignment, by means of the pier masonry cranes. The lower chords of the shore spans, which are supported at their extremities by a hinged post, were next erected, this being in the autumn of 1898, and at once connected at their extremities to funicular attachments of the anchorage piers, and the other ends were temporarily made fast by cables to the tower pedestals on the piers. A gantry crane on either shore handled the materials, which had been suitably stored on high skids on the quays to keep them above the surface water during the winter.

The hinged posts, Fig. 6, steadying the unsuspended or cantilever ends of the stiffening girders are secured at their lower ends to pivoted steel-casting pedestals bolted to the masonry foundation, their pins being 260 millimeters diameter, with a length of bearing in the pedestal of 300 millimeters, and in the re-enforced plates of the post of 46 millimeters. The foundation pin is hollow, being bored with a hole 40 millimeters diameter, and the pin at the upper end, in the extremity of the boom, is solid, 250 millimeters diameter by 636 millimeters long, with a length of bearing in its bushes of 122 millimeters. Between pin centers the height of the hinged posts is 8.90 millimeters. The post sides are of plates 720 millimeters by 16 millimeters, put together with angle ties 70 millimeters by 70 millimeters by 8 millimeters, and diagonal lattice bars 70 millimeters by 8 millimeters. Just above the lower pin first mentioned are situated the devices for the horizontal alignment of the stiffening girders during the construction of the connection of these trusses. They consist of rectangular frames formed of deep I-sections bolted to the upper half of the steel pivot which is thus fixed to, and moves longitudinally in common with the post. This frame is prolonged transversely beneath inverted abutments in the masonry provided with cast-iron chairs, and having inclined planes on their lower surfaces permitting of motion in a longitudinal direction. Between these, and seatings or slides riveted on the extremities of the rectangular frame, are forged steel wedges 120 millimeters long, with rounded backs, adjustable by 20-millimeter set screws. Transversely to the bridge axis these posts are not absolutely rigid with the sides of the pedestals, for a raised collar, 45 millimeters wide, around the pin holes, gives a clearance of 8 millimeters between post plates and the casting.

The stiffening trusses, which distribute the weight that is carried by the chains, so preventing deformations from moving loadings and swaying of the cables, have a width between boom centers of 20 meters. Their height between boom flanges is 4.75 meters at bridge center, increasing to 6.985 meters over the piers and decreasing to 3.990 meters at the abutment ends of the cantilever trusses. The greatest height of the stiffening truss over flanges is equal to 1-42 of the river span. The chords are only parallel in the 100-meter parabolic section at the middle of the bridge. The road gradient is carried parallel with the top chord throughout, the height of the latter above the mean level of the footways being 1.25 meters. The lower chords in the parallel section stand 3.5 meters below the road center, and at the pier centers 9.60 meters above M. W. L. The width of the flange members is 850 millimeters, and the distance between the inside faces of the web members of a same truss is 576 millimeters. The total weight of the stiffening trusses is 2.132 tons, or nearly 5.7 tons per meter run of the bridge.

The lateral bracing of the stiffening which, it will be remembered, is continuous throughout the structure, consists in the channel span of four trussed cross girders and one counterbracing to each panel of 6 meters length, and at the intersection with each cross girder the main trusses are suspended to the chains. In the shore spans the panels are 4 meters long, except for the two next to the towers, which are 4.5 meters and 5 meters respectively, and here there are three cross girders and one primary wind-bracing to each panel. The wind-bracing is connected to the lower chords, and at its extremity in the end panel it is attached by gusset pieces to a horizontal cross beam 2.600 meters long, having spherical ends which ride between guide blocks in lateral abutments built in the center of the anchorage pier. A secondary diagonal bracing is built into the end panels only.

At the intersection of the wind-bracing with the center line of the piers between the posts, where the main girders are carried on rocker arms, there is stiffer counterbracing, so arranged as to be free to dilate longitudinally along with the main trusses to which it is attached. The weight of metal employed in the wind-bracing amounts to 209 tons.

All the 20-meter trussed cross girders are attached to the verticals in the web of the stiffening trusses save at the line of the towers and are webbed vertically between their posts by a double series of symmetrical latticing, united at the points of intersection with intersection plates. The height between their chords ranges from 2.5 meters to 3 meters, and the length of each panel is 3 meters. The lower chords are horizontal, and built up of plate girders 380 millimeters by 12 meters, and two angles 80 millimeters by 80 millimeters by 10 millimeters, while the upper chords—girders 390 meters by 12 meters—are inclined at an angle of 1 in 40 toward the longitudinal axis of the bridge. The cross girders built to the stiffening trusses at each panel point slung from the chains add 430 tons to the weight of the suspended structure. Upon their upper chords, and immediately above each of the truss verticals, is a row of seven stringers of rolled I-section,

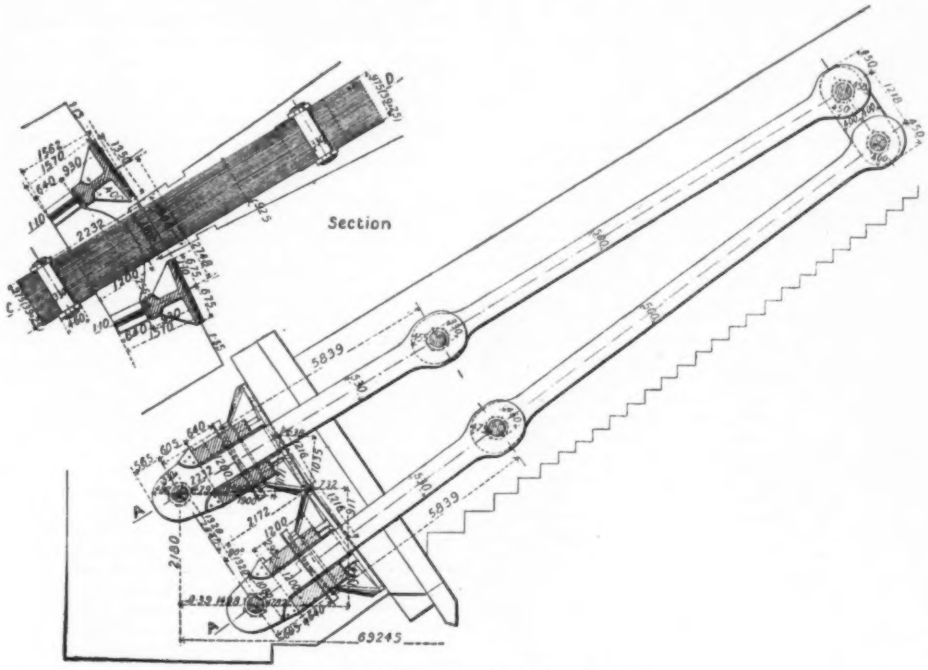


FIG. 4.—DETAILS OF ANCHORAGE.

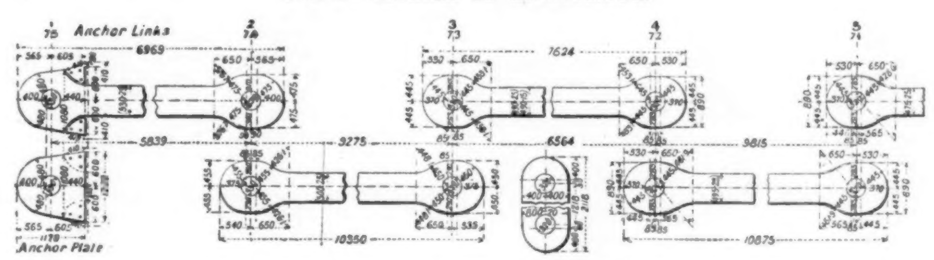
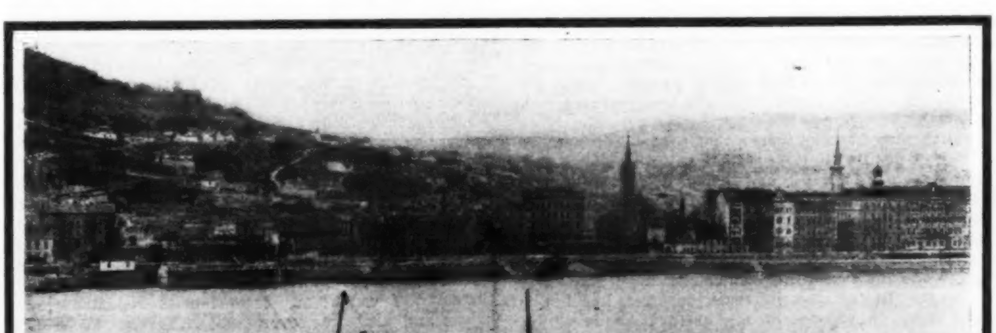


FIG. 5.—ANCHOR LINKS AND EYE-BARS.



ONE OF THE TOWERS IN COURSE OF CONSTRUCTION.

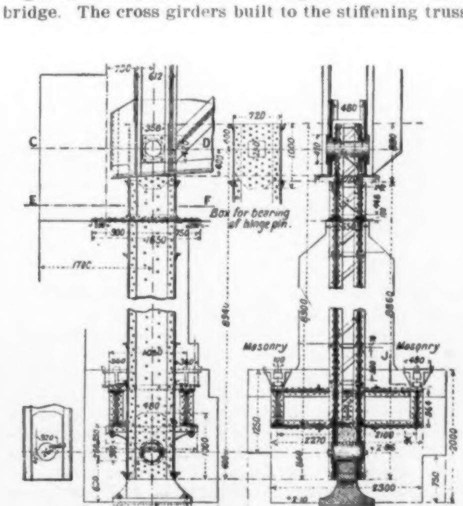


FIG. 6.—HINGED POST.

750 millimeters high by 150 millimeters across the flanges, four out of which longitudinal girders support the promenades, and three the middle portion of the floor. To the central part of their webs is attached, by four angles 70 millimeters by 70 millimeters by 8 millimeters, a system of secondary cross girders, 220 millimeters by 102 millimeters by 9 millimeters, and by 13 millimeters, which in turn carry longitudinal floor beams 240 millimeters by 8 millimeters by 9 millimeters, supporting, together with the three stringers mentioned, the buckled plate decking of Zorès section—which has a depth of 87 millimeters, and is, in turn, covered with layers of asphalt and concrete, with wood planks on the top, all three aggregating 95 millimeters in depth, but the wooden planking is omitted below the train track. The longitudinal bearers are placed between each of the middle stringers, and are fixed to the secondary girder with angle struts, one on either side, forming chairs; but outside of the third stringer only one longitudinal bearer is laid, since the conduit for the electric street railway itself stiffens the floorwork between the main cross girder and the wood paving. This electric conduit is placed under the near rails of the track, on one side, and, necessarily, under the off-side rails on the other side of the bridge, the track in both cases being laid close up to the wheel-curbs of the promenades. Underneath the tram tracks, and suspended to the lower chord of the main cross girders, are small inspection service gangways, which, in general, have a width of 1 meter, and a height of 90 centimeters. The material for the street railway tracks, that is the longitudinal bearers, Zorès plates, buckled plates for scuppers, service gangway, etc., has a total weight of 261 tons. The material used for the buckled plates mentioned, and for those of the sidewalks is Martin steel, having an ultimate tensile strength of from 3,300 kilos to 4,000 kilos, giving at those limits respective minimum elongations of 26 and 22 per cent. The promenade stringers, bearing upon the chords of the trussed cross girders, directly support joists 160 millimeters by 84 millimeters, by 6 millimeters and by 9 millimeters, to which are attached the buckled plates, carrying the pavement. The promenade hand railing is riveted to bracket pieces on the joist ends, and at a distance of 550 millimeters from the inside of the stiffening truss inner webs.

The street railway scuppers for surface water between the outer rail and the footway curb are 442 millimeters wide by 475 millimeters deep, and laid with buckled plate bottoms 2 millimeters thick. The cast-iron conduit for the telephone wire is carried by the main cross girders under the southern footway—this conduit, with its expansion bearings, weighing 42 tons; while the gas mains are similarly carried on the northern side, the cast-iron brackets therefor weighing about a ton.

The whole of the bridge structural work, including towers, is of Siemens-Martin mild steel—*flusseisen*—and comprises in the bridge spans and including truss suspenders, a weight of 3,801 tons, besides 2,082 tons for the superstructure of the towers; it has a minimum ultimate tensile strength of 3,500 kilos., and a maximum of 4,500 kilos. per square centimeter, and, in the test specimens 200 millimeters long, with a maximum sectional area of 4 square centimeters, and at the limits named, yielded minimum elongations of 28 per cent and 22 per cent. Perpendicular to the rolled direction the material yielded elongations of 26 per cent and 20 per cent respectively. All rivets are of the same material, and have a tenacity of 3,500 kilos. to 4,000 kilos., with elongations of 32 per cent and 26 per cent respectively.

The maximum unit stresses allowed per square centimeter of sectional area are 1,100 kilos. in the main girders, 1,200 kilos. in the towers and in the windbracings, 850 kilos. in the floor members and in the suspension bars, or hangers, and a shear on the rivets of 850 kilos.; the stress calculated upon the bearing diameter of the rivets and bolts being 1,800 kilos.

The following maximum unit stresses were calculated in dimensioning the floor members and suspension rods. Two four-wheeled lorries of 16 tons each placed side by side, having a width between wheels of 1½ meters, and a wheel base of 3 meters, and equal to a uniformly distributed load of 450 kilos. per square meter. For the sidewalks, stiffening girders, towers, and chains, the same load was calculated. The highest pressure estimated for wind force on the unloaded bridge was 250 kilos., or 150 kilos. per square meter on the bridge when loaded.—Engineer.

In a paper published in No. 8 of the Physikalische Zeitschrift (April 15), W. Biegon von Czudnochowski proposes a theory of differential arc lamps, comprising a cylindrical iron core and two identical coils, symmetrical to the latter, one of the coils being the only movable part of the system. It is found that for a given construction, the highest sensitiveness with respect to regulation is obtained if the regulating position is such as to give values as high as possible to the attractive forces of the two coils. In order to obtain this, the distance of the regulating coils should be so chosen as to have the maxima of the attraction curve coincide. In the case of the same lamp having to be used with other electrodes, giving an arc either longer or shorter, with greater or smaller values of dE/dL than those originally determined, the increase or diminution of the stroke necessary to compensate for sudden current impulsions in inserting, as well as on account of any lack of homogeneity of the electrodes, should not be effected by displacing the coils with respect to one another. By placing the core asymmetrically, in the regulating position, and by aiding mechanically the coil from which the center of the core has been removed, it is possible to obtain a special sensitiveness of the lamp either for current or for tension oscillations with the same normal values of the current and the tension.

ENGINEERING NOTES.

Great was the amazement of all Europe when at about the close of the 18th century William Murdoch discovered that gas could be used for illuminating purposes. So little was the invention understood by those who had not seen it in use that even the great and wise (?) men of the British Parliament laughed at the idea. "How can there be light without a wick?" said one member of that august body, with a wink and a knowing nod. Even the great Sir Humphry Davy ridiculed the idea of lighting towns and cities with gas. He one day asked Murdoch, "Do you mean to use the dome of St. Paul's for your gas meter?" Sir Walter Scott also made merry of the gas idea and of the coming attempt to "illuminate London with smoke from a tar factory." When the House of Commons was finally lighted with the new illuminant, the architect and custodian of the building, who imagined that the gas ran as fire through the pipes, insisted that they be removed several inches from the wall to prevent the building from taking fire. Several distinguished members were also observed carefully touching the pipes with their gloved fingers and then smelling of them to see if they could detect the odor of burned leather.

Fire fighting has been reduced to a science in a model system installed for the protection of the World's Fair at St. Louis. Tests have demonstrated the efficiency of the water supply, and the organization of the fire fighting forces. With a pressure of 175 pounds to the square inch, and a capacity for increasing this by one-half, each of the hose rigged hydrants distributed over the grounds, on the roofs, and through the buildings is in itself the equivalent of a fire engine. Twenty-four miles of water mains, tested to 300 pounds pressure, are distributed in the Exposition district. These are fed from the city mains, fourteen great pumps supplying the additional pressure. Should the city supply at any time be inadequate the Exposition pumps would tap the reserve store of 9,000,000 gallons in Laguna de Bay, the largest of lagoons or landscape waterways, with which they are connected by a 24-inch gravity pipe. Along this line of mains, entering every section of the grounds, are the hydrants and fire plugs, each capable of supplying from one to four streams. Beside the large buildings standpipes have been built and from their tops deck turrets have command of the roofs. Inside fire plugs are at frequent intervals and automatic sprinklers have been provided. For every 2,500 square feet of space in the buildings there is a six-gallon Babcock fire extinguisher and tank. Men whose business it is to watch for an outbreak of fire are constantly on hand to use the emergency equipment, pending the arrival of the firemen. Seven fire companies compose the regular Exposition force, but this is reinforced by twelve companies which may be called into service from the St. Louis fire department, and the full equipment of the Hale fire-fighting corps, which has a concession on "The Pike." Forty expert firemen detailed from the city departments of Denver, Kansas City, Brookfield, Mo., Chicago, St. Louis, and New York form this combination, which furnishes daily exhibitions of feats in fire fighting.

ELECTRICAL NOTES.

The new electric line from Schwyz to the town of Seewen, a railroad station on the St. Gothard line, is the first portion of an extensive electric railroad which is to connect Seewen, Schwyz, and Brunnen with the shore of the Lake of Four Cantons. This is the second electric-traction line in Switzerland to use three-phase alternating current direct from the line, without previous transformation to continuous current. The other line is that of Lugano, where the system was applied in 1895 by the Brown-Boveri Company. The length of the new road is 11 miles, and it has 190 feet difference of altitude between the terminal stations. Under the present conditions of heavy grade the use of the three-phase current has great advantages, seeing that the speed of rotation of the three-phase motors remains nearly constant when the load varies from zero to a maximum. In the present case the train has but a single speed on account of the uniform grade which commences at the starting point and continues regularly to the terminus, and thus the load on the motors is almost constant. The motor with a revolving field, which has proved of great value on a level grade, is especially useful for mountain roads, as the almost synchronous running gives it a constant speed, and thus the speed when on a level and when climbing a grade is about the same. The tests showed, in fact, only a small percentage difference. Hydraulic power is obtained from the Muota, which empties into the Lake of Four Cantons. It gives a 22-foot head of water and can furnish 2,000 horse-power. The water, collected by a dam 50 feet long, descends a canal for about a mile and then runs in a penstock 650 feet long to the station. The latter will eventually contain six turbine and dynamo units, of which four are now in place. The turbines are of the horizontal type and deliver 500 horse-power, working at 400 revolutions per minute. The dynamos, which are direct coupled, give 450 kilowatts, delivering 8,000 volts and 40 amperes at 40 cycles. These machines can produce both single-phase and three-phase current.

In No. 7 of the Physikalische Zeitschrift (April 1, 1904), Mr. E. Lecher shows J. J. Thomson's electrodeless annular current to be produced in the following way: 1. Between the ends of the coil there arises a large oscillating potential difference due to impedance, resulting in a reciprocating flow of electricity in the vacuum, in addition to the strong ionization of the gas. 2. This luminescence is thrown toward the edge by the magnetic forces of the coil. 3. There is likely to occur a further increase of the luminosity due to the induction currents proper, which, however, may exist only in gases of specially high ionization.

In a paper recently published in the Elektrot. Zeitschr. (vol. 25, No. 12, 1904), Prof. W. Peukert shows that the range of a voltmeter or electrometer is augmented by connecting to the instrument a capacity, when the sensitiveness of the instrument is altered within wide limits. In fact, in the case of an additional capacity, C_1, being inserted in series with a similar instrument and applied to an alternating tension, E, the relation

$$E = \frac{C_1 + C_2}{C_1} \cdot e_2$$

is derived, where e_2 is the tension on the capacity, C_2, of the instrument. This relation may be used also for designing an instrument susceptible of measuring a given tension outside of its range.

In order to test some experiments made by Mr. Egg-Sieberg as far back as 1900, M. F. Schneider in a paper recently published in the Elektrot. Zeitschrift (vol. 25, No. 12, 1904) made the following experiments:

After coating one-half of a long and thin iron wire with a thick layer of asbestos ribbon, the end of the asbestos was heated by means of a gas flame, when the steeper temperature gradient was found in the direction of the free wire, whereas the current would flow from the flame to the coated wire. The potential difference, after increasing gradually, reached a maximum of about 0.5 volt after a time ranging between one and two hours, the wire being heated up to about 1,000 deg. C. Now, on allowing the wire to cool down and heating it again afterward, the potential difference was found immediately to reach its maximum value.

An iron wire being clamped between two iron jaws and heated at its point of contact gave rise to a current flowing from the heated place to the portion cooled by the iron jaws.

An iron wire heated by a flame and cooled suddenly on one side of the flame by means of two iron jaws, showed a current flowing from the cooled to the heated places.

Two iron wires of the same material but of different diameters being united mechanically, gave rise to a current flowing from the thin to the thick wire, on the connecting points being heated.

From the above experiments, it is inferred, in opposition to the hypothesis suggested by Egg-Sieberg, that the behavior of the temperature gradient does not determine the direction of the current. The author points out that the current always flows toward the portions of the wire where the oxidation is strongest, which in his opinion accounts for the phenomenon. Similar results were obtained with wires of German silver, copper, and platinum.

As pointed out in the paper recently read before the French Academy of Sciences, Mr. R. Paillot submitted a bismuth spiral, placed between two thin mica plates, to the action of the radiation given off from 0.03 gramme of radium bromide (radio-activity 500,000), placed within a thin-walled glass tube. The electric resistance of the bismuth was measured according to the method used by Mascat and Beunoit in reproducing ohm standards. The manganine wire of the bridge was carefully calibrated and showed an electric resistance of 84×10^{-6} ohm per milligramme, a vernier enabling variations in the resistance not exceeding 4.2×10^{-6} ohm to be measured. Any stray E. M. F. was eliminated by inverting the direction of the current in each experiment. On account of the sensitiveness of the galvanometer, only very small currents could be used for very short intervals of time. The plane of the bismuth coil being placed vertically, the radium bromide tube could be approached up to a distance of 0.5 millimeter.

Now the author stated that the radiations given off from radium bromide would lower the electric resistance of bismuth as they are known to lower the resistance of selenium. Experiments repeated many times and made on several days gave as the average of the diminution in resistance for a distance of 0.5 millimeter, the value $\delta R = -52 \times 10^{-4}$ ohm.

The initial value of the resistance of the bismuth coil was $R = 15.1034 \times 10^{-4}$ ohm at the temperature of 18 deg. C. The action of radium bromide is practically momentaneous, varying only in the case of the tube being kept for a long time in the neighborhood of the bismuth. As soon as the distance is augmented, the action is rapidly diminished, becoming zero at a distance of 1 centimeter. In the case of the tube being withdrawn, the bismuth resumed nearly instantaneously its primitive resistance.

The apparatus used by the authors embodies a highly sensitive bolometer. By numerous comparative tests, Paillot convinced himself of the fact that the variation in the resistance was not due to a tube colder than the spiral approaching the bismuth. When interposing a sheet of black paper or a thin aluminium plate, the action of the radium bromide was found to decrease without, however, disappearing completely.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Agricultural Implements in Russia.—The year 1903 has been a very satisfactory one for the sale of agricultural machines and implements. The American articles in this line continue to hold the field, and their number is increasing. Harvesters, binders, reapers, mowers, rakes, cornshellers, etc., have always been in favor in the country and their sale has been large. The American plow has now secured a permanent foothold in Russia, and its future promises to be a very satisfactory one.

In the Daily Consular Reports published by the Department of Commerce and Labor on September 23, 1903, there appears an article taken from Das Handels-Museum of August 6, 1903, relating to agricultural machines in Russia; this article being a report from the German consul-general at Odessa to his government. It stated that a sharp contest in the sale of agricultural machinery had just broken out in Russia, and that Germany could not hold her own in the sales of steam thrashers with locomotive attachments with Great Britain, owing to the cheap sea freights from England. It was further stated that the United States was once supreme in this field.

This is entirely erroneous, as the United States never had the field in thrashing outfits. It is quite safe to say that in the last forty years less than thirty thrashers of American make have entered this country. During the past five years I do not know of one of our steam thrashing outfits having been sold in all Russia. Many years ago an effort was made to place these machines on this market, but the effort was a complete failure. The American thrasher did not meet the requirements of the trade in this country and consequently could not be sold. In the first place the American outfit looked too light in appearance to suit a taste long familiar with the heavy and cumbrous-looking English machine. It was quite useless to tell the Russian farmer that it was not necessary that a machine should look heavy in order to be strong. Another reason for the non-success of the American machine was the circumstance that the outfits which were brought to Russia and offered for sale were so constructed as to have but one spout through which the grain was sent when thrashed. The English machine had three spouts and each delivered a different grade of grain, and delivered cleaned. This feature of the English-made thrasher is only found in such machines as are sent to Russia.

The Germans also send steam thrashing outfits to this country, but as these outfits are simply reproductions of well-known English machines the people prefer to purchase the latter article. Nevertheless, the German-made thrashing outfit is largely sold in this country and gives satisfaction. The advent of the Germans in this line has resulted in marked improvements both in the engine and steam thrasher. A circumstance worthy of note is the fact that the engine and thrasher which may be suitable for home requirements is not suitable for export. This is recognized both by the British and the Germans; and while the three-spout machine is not in use in Great Britain, it is always found in the thrasher exported from Great Britain to Russia. It is the same with the German outfit. For years the English insisted on forcing on the market their favorite low-pressure engines, for the reason that in a country like England, where coal was cheap, such engines worked satisfactorily and cheaply. It was the same with the Germans for awhile, but of late the Germans have been building high-pressure engines up to 6 atmospheres. This forced the English to follow or else lose their Russian trade, and they now make an engine for Russian use which is up to 5 atmospheres. Fuel is expensive in Russia; hence these changes. I know of one German house here which sold 80 steam thrashing outfits last year, and I am given to understand that other German-made machines were sold in large numbers. I am also reliably informed that there were more German thrashers and engines sold last year, and thus far in 1903 also, than were sold by the numerous houses here representing the English article. I dwell on this question of steam thrashing outfits because I am firmly convinced that the American outfit would meet with success if it were properly handled in this country. The homemade article is so well and so favorably known throughout the United States and has so well answered all local requirements as to make it seem ungracious to suggest a few changes in both engine and thrasher in order to meet the requirements and taste of the foreign buyer. After all it is not a question of pride or sentiment, but of business, and that business can be made a great one in Russia, once the buyer is satisfied. The following well-known manufacturers of steam thrashing machinery are represented at Odessa:

German.—Gesellschaft vorm. Th. Floether; Heinrich Lanz, Badenia; Garret & Smith; Gesellschaft Lehnigk.

British.—Ransom, Sims & Jefferies; Marshall & Sons; Ruston, Proctor & Co.; Foster & Co.; Robey & Co.; Clayton & Shuttleworth; Richard Garet & Son.

Hungarian.—Koenigliche Ungarische Staats Fabrik in Budapest.

These names practically represent the manufacturers of steam thrashing machinery in Europe.

There is no representative of American steam thrashing machine manufacturers in Odessa.

The sale of garden tools of American make shows an annually increasing market in this country. Tools of various kinds, representing the finer qualities of the American articles, are also found on this market and are meeting with high favor. Knives for harvesters, mowers, reapers, etc., had a very large sale during the present year (1903) as well as in 1902.

The American automobile made its début at Odessa for the first time during the present year, and a few machines were sold which have given great satisfaction.—Thomas E. Heenan, Consul at Odessa, Russia, November 30, 1903.

American Products in East Central England.—The products of the United States sold in this district—which embraces the shires of Nottingham, Derby, Lincoln, and Leicester—being so great in quantity and variety, it is difficult to suggest openings for additional kinds or to offer hope of increasing the sale of our products now used there.

Silverware.—In some cases where articles of American make are now unrepresented there are apparently insurmountable difficulties. To illustrate, American silverware is rejected on the ground that it is too ornate and too light; the English preferring heavier and perfectly plain ware, dealers will not consider any other kind.

Shoes.—The trade in American shoes is considerable in this locality, but it is not increasing. Complaint is made by dealers that, on the whole, the leather is inferior and does not wear as well as the English product. The price is rather higher than good shoes can be bought for in the United States, $4 being the lowest price here for a good American shoe for men. It would seem that the $2.50 to $3.50 make of shoes in such favor in America with men, who find them very durable, would command a good sale here, but I have seen none of them in this market.

Bicycles.—At one time American bicycles were marketed in this locality, but not one is now to be found here unless belonging to a resident American. The hostile expressions heard indicate that an American wheel could not be disposed of here except as a gift; for it is alleged that the people who bought wheels made in the United States were "cheated with worthless rubbish dumped on this market at prices just low enough to undersell the home market." There appears to be some truth in this, but the hostility arises partly from sympathy with local bicycle factories, which claim to have once enjoyed a lucrative trade with the United States, built up at a heavy expense, but destroyed, it is alleged, by the imposition of heavy import duties. The bitter resentment felt and freely expressed by these bicycle makers is shared, more or less, by the general public.

Sewing Machines.—Many thousands of sewing machines are used in the lace and hosiery factories. In Nottingham and Leicester alone nearly 200 firms are using American overlock machines. In a single room of one factory 180 are running. Twenty firms use over 1,000 high-speed lock-stitch machines, which have a speed of 4,000 stitches a minute. These machines are all made in the United States. The sale is pushed by energetic resident agents, exclusively employed. This is the proper method. Its general use by present or would-be American exporters would soon double our foreign trade in various lines.

Some German and British sewing machines are also found in local factories, but they are altogether inferior to the American, are used for simpler purposes, and only because they are cheaper, or because, being in, the characteristic hesitancy about making changes lets them stay.

Butter.—England relies, to a great extent, upon imports for its butter and eggs. Denmark alone sells daily to England over $200,000 worth of farm products, chiefly butter. English butter is generally unsalted and becomes rancid in a day or two. Danish butter resembles our western dairy product and keeps sweet and fresh indefinitely. It retails here for 25 to 30 cents, the price generally ruling 2 to 6 cents less than that of the home product. The popularity of Danish butter is apparently responsible for the charge recently circulated in England that much of it is, in fact, only Russian butter repacked in Denmark, which is circumstantially denied in that country. Much more Danish than English butter is used in this country. One grocery store alone, in this city, sells a ton of it a week. England's annual import of butter amounts in value to about $90,000,000, most of it coming from Denmark. The share of the United States is only about $3,000,000. Only wheat, wool, and cotton equal butter in value of import.

Eggs.—The eggs sold here are of three kinds—new-laid eggs, fresh eggs, and eggs. "New-laid eggs" are brought from neighboring farms and sell just now for 36 cents a dozen; "fresh eggs" are supposed to come from Ireland and retail at 30 cents; "eggs" are imported from foreign countries, chiefly from Russia, and sell for about 18 cents a dozen. The value of these imported eggs is about $30,000,000 annually, of which the United States sends less than $1,000,000 worth.

It would seem that at such prices as butter and eggs command here they might be profitably exported from the farms of the United States in much greater quantities than at present.

Hay.—A Texan who was recently visiting in this country discovered that hay sold in this market at a much higher price than that ruling in his State. Figuring on the cost of freight from Texas to this city, and all other expenses incident to transportation, he informed me that with Texan hay he could undersell the home product in this market and make a fair profit, and that he had fully decided to try the experiment.

Canned Fruits.—All kinds of American canned, bottled, dried, and smoked fruits and other edibles are sold in the principal groceries here at practically the same as American prices, the cost of ocean freight being but nominal.

Office Furniture.—Firms making a specialty of office furniture sell more American than English goods. Practically the entire equipment of dentists' offices is American.

How to Hold British Trade.—In going over the various kinds of practicable exports from the United States to England it is difficult to find any vacant opportunities. The most a consul at this post can suggest is that care be taken to prevent any disappointment in the quality or the preparation of goods, and that liberal terms of payment be given in order to still further increase the sale of the American articles now used here. —Frank W. Mahin, Consul at Nottingham, England.

American Goods in French Inland Cities.—Among the new buildings and other city improvements of Grenoble during the year just past, another "department store," on a large scale, made especially attractive and presenting many modern features, is worthy of notice. While it follows the lines of similar stores in French cities, it is noticeable that its goods, varied as they may be, are yet almost wholly "made in France."

It is lacking in a hundred and one commodities which go to make up "all the comforts of home" in the United States. Asked wherein it differed from an American store of the same class, I could only say: "In its limitations. It lacks the products of other countries, of the world in general, and of the United States in particular.

How to introduce American goods into these inland cities?

Correspondence, the placing of circulars, the securing of merchants' names, even the occasional visitations of agents or exposition of scattered samples are slow processes at best. People will look with semi-curiosity at an American washtub and clothes wringer and proceed to hammer their clothes at the water basin in the same old way.

I have often thought as American dentistry has planted itself in European cities and demonstrated the quality of its work by daily practice, so the planting of American stores, on a smaller or larger scale, with specific American goods—household utensils, furniture, tools, garden and field implements, shoes, threads, tongs, stove handles, scores of things I could name—would demonstrate their ability to "meet long-felt wants," and assure to their promoters an ever-increasing patronage.

Even with French high-tariff restrictions, I believe this could be successfully done, while at the same time it would stimulate native dealers to search after and keep on hand more and more of our goods.—C. P. H. Nason, Consul at Grenoble, France.

American Macaroni Wheat Wanted.—United States Consul-General Richard Guenther, of Frankfort, Germany, transmits a communication from Messrs. Genvig Herker & Co., of Basel, Switzerland, requesting information relative to American macaroni wheat. In the recent volume of Special Consular Reports on "Macaroni Wheat in Foreign Countries," Messrs. Genvig Herker & Co. appear in a long list of foreign dealers, given by Consul-General Guenther, anxious to get into communication with the dealers in the American product, with a view to opening up trade therein. Not having heard anything through their first inquiry, they have instituted this second inquiry, showing a desire in this connection which should be responded to by American dealers who seek a foreign market for macaroni wheat.

American Furniture in Hull.—If American furniture were placed on the market here, where English made —old style and heavy—is in use, and properly pushed, I think a profitable trade could be built up. It would have to be good furniture, well made of seasoned lumber, and sold at reasonable prices. It would be useless to put on sale any of the cheap and flimsy styles. Furniture can be exported from the United States to Hull at reasonable rates. The furniture manufacturers might find it profitable to look into this matter.—Walter C. Hamm, Consul, Hull, England.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

SCIENCE NOTES.

During the field season of 1903 most of the cement-producing districts of the United States were visited by members of the United States Geological Survey, and data were collected for a report on the cement resources and industry of the country. The districts not visited in 1903 will be examined early in 1904, and a detailed report on the subject will be published as soon as possible. In the meantime, three papers on interesting cement districts have been prepared and published. One of these districts, in Pennsylvania, now produces about 60 per cent of the total United States production of Portland cement, while the other two, in Alabama and Virginia, which are at present only slightly developed, give promise of becoming important centers of production.—N. Y. Evening Post.

In addition to the flat tablet, the Babylonians and Assyrians wrote some of their books on large prisms and cylinders. Some of these cylinders are as much as 2 feet in length and 8 to 10 inches in diameter. Being made of the same material as the tablets they are necessarily heavy and cumbersome, yet they were in some ways more convenient for reading, since they were perforated longitudinally, and placed on a spindle, so as to revolve. In some cases the writing runs from end to end of the cylinder, which is then suspended horizontally. In other cases the cylinder is upright, the columns running from top to bottom. In the latter case the book is usually not a true cylinder, but a prism of six, eight or ten sides, each side inscribed with a separate column of writing like the page of a book. These prisms and cylinders were commonly selected by the kings to contain records of their deeds. Thus the British Museum contains prisms on which are recorded achievements of such famous conquerors as Sargon, Sennacherib, and the Elamite warrior Cyrus. The last named cylinder has peculiar interest because it describes the taking of Babylon.—Henry Smith Williams, in Harper's Magazine.

Dr. F. B. Williams reports (Med. News) results of the treatment of 42 patients with the rays from radium bromide. Nine of these were suffering from acne, 2 each from eczema and psoriasis, 4 from lupus vulgaris, 1 was a case of keloid, 5 were cases of rodent ulcer, 23 of epidermoid carcinoma, and 4 were cancer of breast. The keloid case has improved, 2 of the 5 cases of rodent ulcer have healed, and 3 show improvement. Of the cases of epidermoid cancer, 11 have healed and 12 are improving, and of the 4 breast cases 3 are improving. The author made experiments to test which were the more beneficial, the beta or the gamma rays from radium; these showed that the beta rays do not penetrate and are therefore suited for superficial treatment, while the gamma rays have a marked power of penetration. His conclusions are as follows: Experience thus far teaches that there is much similarity between the action of the radiations from radium and the Röntgen rays; that if the results obtained by radium prove permanent, this new therapeutic agent will be largely used instead of the Röntgen rays, but that the two will supplement each other. Certain diseases promise to yield more readily to treatment by radium and others to the Röntgen rays. A disease that has attacked different parts of the body of a given patient may be better treated in certain regions by radium and in others by the Röntgen rays. It is quite possible that in some cases the two remedies used together on the same area and at the same sitting may accomplish better results than either alone.

The Boston Advertiser has something to say about steel frame buildings, which is not very new, but in the course of which it mentions the fact that "iron structural work" has recently been found at Herculaneum, in such good condition, after being buried in the ground for more than eighteen hundred years, that "it is now being employed in a modern Italian building." It is hardly conceivable that pieces of antique structural iron, the only ones, if we are not mistaken, ever found, except the fragments of lattice girders in one of the Roman baths, should be allowed by the vigilant Italian officials to be appropriated by local builders; but supposing the story to be true, search should at once be made for other specimens, in order that they may be analyzed for the benefit of science. It is now known that Herculaneum, instead of being overwhelmed by a flow of lava, as is commonly supposed, was buried in fine ashes of the same sort as those which covered Pompeii; but at Herculaneum the shower of ashes was accompanied by heavy rain, which packed the dust and cinders into a mass which has now become almost a solid rock. It is known that the eruption which destroyed Herculaneum was accompanied, like other volcanic eruptions, with the disengagement of vast quantities of sulphurous acid gas, which would, presumably, have been absorbed by the rain, and carried down into the mass of ashes. Any iron buried in these ashes would, then, be exposed for many months, until the moisture had completely dried out of the mass, to the action of watery vapor combined with sulphurous acid. This would very rapidly destroy any modern iron or steel, and a metal capable of resisting its action deserves to be carefully studied. Some small pieces of iron have been found at Pompeii, under dry ashes, still recognizable, although corroded, but we are told that these fragments from Herculaneum were, when found, "in as good condition as when first used." Possibly the iron may not have been in actual contact with the moist and acid mass; and it may be that the solidifying of the coating above it prevented circulation of air, and in this way kept off corrosion; but, in any case, the matter is of great practical importance.—American Architect.

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Scientific American Supplement.

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